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QUARTERLY

OF THE

National Fire Protection Association

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National Fire Protection Association.

(INTERNATIONAL.)

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Reports of fires appearing in the QUARTERLY *are copies of or extracts from written reports forwarded to the Association. This Association, as a body, is not responsible for the statements or opinions of any of its members.*

The recent Paris Department Store Fire involved a loss estimated at 40,000,000 francs. (See report on page 262.)

The Quarterly

Vol. 15 January, 1922 No. 3

Electrical Fire Hazards. The publication by the National Board of Fire Underwriters of fire-cause statistics for the five year period 1915-1919 shows a property loss for that period from electrical fires of $84,086,471, an amount greater than that attributed to any other single cause. The central station interests, purveyors of electric light and power, organized as the National Electric Light Association (member N. F. P. A.) have requested of the Actuarial Bureau of the National Board a tabulation of the specific origins of the fires reported under the general classification "Electricity"; that is to say, a statement of just what percentage of these losses are due to overheated electric pressing irons, short circuits in flexible cords, improper fusing of circuits, etc. (Fires due to lightning are not included in this classification.)

An indication of the burden assumed by the National Board of Fire Underwriters in the conduct of this work is the fact that in the year 1920 over 705,000 fire reports were received, examined and classified by this bureau. The causes of these fires, where the causes can be ascertained, are set down with reasonable accuracy by the adjuster or agent settling the loss. If the National Board were to undertake an investigation of the specific origins of every fire it would require an organization vastly larger than the one it now maintains, and it would be entering the proper field of the city fire marshals and fire department divisions whose function it is to make such investigations.

It is not unnatural that the electrical interests should turn to the underwriters for information regarding the fire hazard incident to the uses of electricity. All the other special interests, the conduct of whose business incidentally causes fires, instinctively do the same thing. This impulse springs from the common notion so amazingly deep rooted in the United States that the underwriters pay the fire waste, and are therefore the only persons logically interested in preventing it. This notion is reflected in the legislation of those states which in the establishment of the office of the fire marshal assess the cost of it upon the fire insurance companies, and again in the difficulty of inducing juries to bring in a verdict for the punishment of arson. Through this stupid habit of mind and profound ignorance of economic realities the people of America for a quarter century have been performing successfully the interesting comedy of a man cutting off his own head. It is presumably upon this

The recent Paris Department Store Fire involved a loss estimated at 40,000,000 francs. (See report on page 262.)

confusion of thought and the continuance of it that the tobacco companies rely in ignoring all appeals of the underwriters for co-operation in educational efforts to reduce the fires due to smoking, and even ignore with a rare cynicism appeals from the Department of Agriculture of the United States to assist in attempts to reduce forest fires by warning the careless smokers.

One cannot help but sympathize with the contention of the electrical fraternity that the greater portion of the bewilderingly large number of fires attributed to "Electricity" are caused by pure, unadulterated carelessness, or ignorant tampering with electrical circuits. The electric light companies are well administered and every reasonable precaution is taken to insure that no injury shall result to their subscribers through any fault of the company. The electrocution of the West Peabody (Mass.) woman last month in attempting to renew a fuse on the electric meter-board in her cellar was an unusual case. All the wire lines in New England had been previously upset by a severe sleet storm. Very seldom can a fire or accident in these days be traced to a defect in the main lines of the distributing station. It is the woman who leaves the current on her electric pressing iron and goes out to gossip with her neighbor; the man who deliberately destroys the protection of his fuse blocks, or the brilliant son of the house who tampers with the house circuits and adds complicated wiring for spectacular purposes of his own who are causing the rapid increase in electrical fires. These are undoubtedly the mischievous agencies against whom the forces of education and persuasion should be directed. Wide-spread and ramified as are the present uses of electricity, the immediate future holds its still greater development. When the water power of the nation finally contributes its proper service to our industrial and domestic life the dirt and dust of coal handling will be avoided wherever cleanliness and beauty are desired. It is because of the inevitable increasing use of electricity therefore, the finest, cleanest, most scientific form of light and power yet known to man, that we should educate our people thoroughly and well to appreciate the potential punishments that reside in its abuse.

Upon what existing agencies shall these educational responsibilities devolve? That the electric light and power companies are interested is manifested by the recent investigations and tests conducted by the National Electric Light Association upon the durable qualities of heater cords, and the present intention of the Society for Electrical Development to prepare and circulate literature of an informative nature upon the proper use of pressing irons and fuse plugs and the danger from poor portable cords. Certain individual electric light and power companies also issue instructive bulletins to their customers.

In view of the desirability of ascertaining, for the purpose of directing this campaign of education to its proper ends, just what are the principal present causes of the growing number of electrical fires, it may very well be that the electric light and power companies may be willing to establish such relations with the fire departments of the cities and towns in which they operate as to insure their receiving accurate reports upon all fires attributed to electricity as a cause. The causes thus reported if tabulated by the National Electric Light Association might furnish the basis for an educational campaign in which it might most adequately safe-

guard the future growth and expansion of the electrical industry. To such a campaign the National Fire Protection Association and its many distinguished organization members would assuredly most heartily contribute their co-operation and influence.

* * * * *

Motion Picture Film Water Damage. A question has arisen as to the susceptibility of motion picture films to damage by water. The manufacturers of film are aware of this susceptibility, but the layman is apt to be misled by the fact that nitro-cellulose which forms the body of the film is impervious to water at ordinary temperatures. W. J. Tallamy of New York (Member N. F. P. A.) contributes some informative comment on this subject which may be interesting to his fellow members. Mr. Tallamy points out that as a matter of fact the nitro-cellulose strip is not the film, but simply a transparent substance on which the film is mounted. The film consists of a sensitized gelatine emulsion applied to one side. This emulsion is soluble in water at a temperature of less than 100° F. and will soften, expand and become sticky when exposed to water at a temperature of 70° F. or more. Knowledge of this fact breeds, on the part of those handling film, a disbelief in its salvaging possibilities after accidental exposure to water, which is apt to cause indifference likely to result in unnecessary loss.

While motion picture film is very susceptible to water damage, under favorable working conditions and with prompt and proper handling after the exposure, the probability of damage can be materially reduced.

Film that has been unreeled and knocked about when wet, is more than likely to be damaged beyond recovery; therefore the first step to take in the prevention of water damage to film is to see that it is stored and handled in a manner least likely to permit it to be unreeled and knocked about in the event of fire or accidental operation of sprinkler heads.

As a matter of convenience in making reproductions, negatives are generally handled unassembled, in short pieces, up to 200 feet in length. These pieces are usually kept in separate reel like rolls with a rubber band around the outside. Pieces sufficient to make up each 1000 foot reel when assembled are usually kept in one container.

Experiments indicate that when the pieces of negative are rolled tight, exposure to water will soften the emulsion on the edges, causing it to expand with a tendency to prevent the water from penetrating beyond the edges sufficiently to damage the picture impressions on the film. Permitting the water to dry before the film is unreeled produces a slight sticking along the edges of the film which apparently does not materially affect its value.

Unreeling the film while wet, however, makes it possible for the water to reach and damage the picture. Therefore, when not in use, motion picture film, particularly negatives in which heavy values are involved, should invariably be rolled tightly with a rubber band around the outside, and kept in strong flat metal containers with tight fitting cover flanging well over the sides; the container resting on its bottom. Under these conditions the possibility of water entering the container in quantities sufficient to seriously damage the film appears to be quite remote.

When exposure to water occurs in a properly equipped laboratory and the film can be handled by experts before the water has begun to dry, it is advisable to run the film off on an immersing frame and put it through the washing and drying process similar to that which the film undergoes after it is developed. Should the exposure occur outside of the laboratory with no proper washing and drying equipment available it is better not to handle the film until it is thoroughly dry.

* * * * *

The Safety Fuse. In the days before the railroads killed the water transportation on the Mississippi River the steamboats used to tie weights on the safety valves of their steam boilers when racing one another and burn pine hams for a hot fire. Sometimes the boilers did not explode and nobody was killed. Civil war time literature is replete with such performances. "Anybody hurt?" inquired his aunt when Huck Finn reported a steamboat explosion on the river. "No'm," said Huck, and then, casually, as an afterthought, "Killed a nigger."

The overloading of fuse blocks in an electrical circuit to obtain a volume of current the circuit is not designed to carry is an act directly comparable to crippling a safety valve. The ways of doing this are legion. Copper wire and hair pins are especially popular for the link fuse blocks, and copper pennies for the plugs. The bridging of fuses of the plug type is creating a considerable prejudice among electrical inspectors against this type of fuse and calling out suggestions for its abolition. Abuses of a particular kind seem to flourish in special localities. The penny is the most common substitute for the proper fuse element in plugs, presumably because of its convenient size to slip into the casing. Chief Electrical Inspector George Welman of the Louisiana Fire Prevention Bureau declares that fires occur daily in New Orleans from plug fuses bridged with pennies and sends us a collection of the latter, fused and pitted by electrical arcs, which the federal government will not permit us to photograph. The Bureau has sent out over 100,000 circulars to the citizens of New Orleans warning them against this tampering with their electrical circuits and explaining the danger of it, without to any measurable extent abating the mischievous practice.

We are wondering if all this unrestrained trifling with electrical equipments is not another manifestation of the present cynical attitude of our people toward the value of human life. The frightful annual slaughter caused by the reckless driving of automobiles; and the death of fifteen thousand men, women and children who perish annually from fires in the United States do not profoundly move the American imagination.

* * * * *

Watch Indiana! In Indianapolis, Indiana, at the most prominent corner in the city there is a large dial upon which move a red and black pointer. The black pointer indicates the number of fires in a month of 1920 and the red pointer indicates the number in the corresponding month of the current year. Each day at 12:30 o'clock noon the fire department moves the red pointer forward and the location and cause of the current fire alarms are given. This fire record is the talk of the

town, and the installation of the dial is the high-water mark of the work of public education in fire prevention undertaken by the local group headed by Frank C. Jordan of the Indianapolis Water Company (member N. F. P. A.), who is chairman of the fire prevention committee of the Chamber of Commerce.

There is already no doubt that the Indianapolis campaign directed by the energy of Mr. Jordan is achieving results. For the first eleven months of 1920, before the educational campaign began, Indianapolis had a total of 3,084 fire alarms; and for the corresponding period of 1921 a total of 2,772 or a reduction of 312 alarms—nearly an alarm a day. Continued progress is indicated by the fact that November, 1921, showed a total reduction of 92 fires as compared to the same month in 1920, or a reduction of three fire alarms per day. At this writing the indications are that the city will show an improvement in the 1921 loss record of more than a half-million dollars over 1920. It is, of course, the reduction in the number of alarms that is the real criterion of municipal progress in fire prevention, as no single big fire can invalidate that record.

And now this achievement of Indianapolis is to exert its proper influence upon the other cities of the state. Fire Marshal Newman T. Miller appreciating the value of Mr. Jordan has attached him unofficially to his staff, and has planned with Mr. Jordan's help a state-wide campaign for the appointment of permanent fire prevention committees in other cities. At this writing Mr. Miller and Mr. Jordan have addressed most enthusiastic and responsive meetings in Evansville and Kokomo and also in Ft. Wayne, where the members of the N. F. P. A. are undertaking the formation of a local chapter. It is planned to work up a state competition for a reduction in fires, basing the standing of each city on its number of fire alarms per month per 10,000 population.

Watch Indiana!

* * * * *

Central Station Heating Reduces Fire Hazards. The idea of heating large groups of city buildings by steam distributed from central heating plants is not new. It has been in operation on a small scale in a number of our larger cities for some years. The obvious advantage is improved economy of operation, but in most cases cost of distribution and other obstacles have interfered with any large scale adoption of this plan.

An interesting application of central station heating to the business center of a small community is described in the December issue of The American City which tells how central station heating is being successfully used in Arcade, New York, a village of 1,300 population in Wyoming County. Exhaust steam from the municipally operated lighting plant is supplied to business buildings at a cost approximately equal to the cost of coal formerly used for individual heating plants, saving to property owners the cost of labor, and incidentally doing away with dust, dirt and anxiety over coal supply, incident to individual operation of small furnaces. The charges for heat, which would otherwise have gone to waste in the exhaust steam of the lighting plant, will pay for the cost of piping installation in a few years and thereafter bring a substantial revenue to the village administration.

One of the principal advantages of such centralized heating is reduction in fire hazard, doing away with the danger of individual fires in the several buildings which are necessarily operated under more or less incompetent supervision and which are a prolific source of fire. The insurance rates in the buildings served by the Arcade central heating plant are on this account lower and the saving in insurance premiums was one of the points considered by property owners when subscribing for the heating service. One very interesting application of this heating service is to one of the old school buildings, a three story frame structure in which there had been six fires in the basement, all caused by various systems of heating formerly used.

This successful experiment in the village of Arcade seems to point a way in which fire hazards in many small communities can be materially reduced. It is a development which may come in time to a wide application as increasing costs of fuel for individual heating and better efficiency in central station plants indicate the economy of such arrangements as those now in use in Arcade.

* * * * *

Enter the Cement Gun. The mother of invention—necessity—stalks up and down in every country, but invention itself, laggard child, is not always opportunely born. The name of the father of invention has never been satisfactorily ascertained, gossip having it that he is not always one and the same, which might suggest to the evil minded that necessity is really no better than she should be; but one of the fathers has, beyond per adventure, been recently identified as a Kansas fire chief.

In Kansas, there is a village called Oneida which achieves distinction by being not far from Seneca, a town which a few weeks ago reflected very proper credit upon the Roman stoic philosopher whose name it bears. Oneida had a fire in a general store. It has no water system. It relies for fire extinguishment upon wells and bucket brigades. Oneida called assistance from neighboring towns and among others the fire department of Seneca responded. What it did when it got there and how necessity gave birth to invention is best described in the words of the Seneca fire chief himself:

When the Seneca crew arrived the store building was beyond hope of saving and the northwest wind had blown the fire to the lumber shed and piles, where it had gotten a very strong foothold. Bucket brigades had already proven ineffectual. Some of the neighboring towns had brought their chemical engines and extinguishers and these had been used but with little success in the open lumber shed. The situation was very bad, as the fire had caught in the northwest corner of the yard and the high wind blowing from that quarter was spreading the fire rapidly to the rest of the yard and made the fire fighting all the more difficult because the firemen had to work with the wind in their faces.

I suggested the use of cement, there being plenty at hand, as a means of checking the fire, but my idea being new to all present, I had to back up the suggestion with forceful orders before it was taken up. The method pursued was this: I had dry cement scattered over adjacent piles of lumber, which were in immediate danger of catching, and had this wetted down by the bucket bridage. I had cement mixed with water, making it quite thin, and had this liquid cement thrown upon the lumber which was ablaze. The effects were prompt and pleasing, even astonishing. Over five thousand feet of lumber was afire when we began the use of the cement, but the spread of the fire was checked almost immediately. No more caught fire

and that already burning began to be abated and within an hour and a half the fire was extinguished. I attribute the saving of about a third of the lumber in this yard to the use of the cement.

The dry cement, which was thrown upon the lumber not yet afire, and wetted down rendered that lumber impervious to fire. The fire did not catch in any of the piles so treated. The liquid cement thrown upon the blazing piles had a threefold effect: (1) It acted similarly to dry powder chemicals, the cement, water and heat having a chemical action which reduced the fire quickly. Yet the effect of the cement was even better than that of chemical powder as it acted in spite of the fact that the fire was out-of-doors. (2) It almost entirely stopped the flying of sparks and timber, thus greatly reducing the danger of spreading fire. (3) It caked over the fire, smothering it and shutting out the air, so that combustion could not take place, thus more quickly and effectively extinguishing it than anything else available.

Another very interesting and advantageous use to which the cement was put was in the case of a large tank of oil, about 400 gallon, in the cellar of the store building. This was an open tank which was ablaze, and into it canned goods had dropped and were constantly exploding and throwing the blazing oil all about and greatly adding to the danger of the spread of the fire. Several sacks of dry cement were thrown into this and eliminated this danger.

Everyone was astonished by the results of the use of the cement. I believe that we could have made a very more effective use of the cement had we had some means of forcibly throwing the liquid cement upon the fire. We had great difficulty in getting the cement upon the fire itself. We were throughout handicapped by lack of fire fighting facilities, but I feel that by using the cement we stopped a fire which would otherwise have entirely destroyed the lumber yard and possibly other property.

The revelation of the presence of the 400 gallon open oil tank in the cellar of the general store in which the fire started is an item which may not bring joy to the hearts of the insurance companies specializing in country stores; but no one can fail to appreciate the dramatic value of the reproduction of Argonne forest by the fusillade of exploding canned goods smothered in a cloud of cement. In fact, knowing the enterprise and farsighted business judgment of our member the Portland Cement Association, we shall be surprised if there does not appear upon the market in the immediate future a cement gun extinguisher of such formidable execution that by contrast the Spirit of Fire will welcome a deluge of foamite as a caress.

Report of Executive Committee.

The Executive Committee by letter ballot submitted November 8, 1921, by the Committee on Laws and Ordinances, officially adopted the following amendments to suggested ordinance regulating the use, handling, storage and sale of Inflammable Liquids and the Products thereof.

Amendments.

(Refer to original text of report submitted to Annual Meeting 1921, *Proceedings*, pp. 65-83.)

Section 2, Classification of Inflammable Liquids: under "representative examples" transfer *acetone* from Class II to Class I, and add to the Class II list, *ethyl acetate* and *methyl acetate*.

Section 21, Exceptions: add at end of section, "Garages and Dry Cleaning" only as given in Chapter I and Sections 38, 39, 40, 41, 42, 43, 44, 46, 50, 51, 52, 55, 56, 57, 60, 61, 63, 64, 65 and 66.

Section 29, Change heading to "Requirements for special storage rooms *or buildings*" and insert the words "or buildings" in first line after the words "special rooms."

Section 30, Storage of Class I liquids: add the following paragraph: In manufacturing plants, the chief of the fire department may permit the storage of Class I liquids in portable wheeled tanks as described in Section 43, where the nature of the business requires such storage and the discharge therefrom. Such wheeled tank shall be used only in special rooms or buildings as given in Section 29.

Section 46, Underground Storage Limited: substitute the following text: Section 46, Tanks located underground shall have top of tank at least three feet underground and below any piping to which the tanks may be connected, except, in lieu of the three feet of earth, tanks may be buried under 18 inches of earth and a cover of reinforced concrete at least 6 inches in thickness provided, which shall extend at least one foot beyond the outline of the tank in all directions, said concrete slab to be set on a firm, well tamped earth foundation. Tanks shall be securely anchored or weighted in place to prevent floating. Tanks shall be set on a firm foundation and surrounded with soft earth or sand, well tamped into place or encased in concrete. Tank may have a test well, provided test well extends to near bottom of tank, and top end shall be hermetically sealed and locked except when necessarily open. When tank is located underneath a building, the test well shall extend above source of supply. The limit of storage permitted shall depend upon the location of tanks with respect to the building to be supplied and adjacent buildings, as follows:

Under "maximum capacity of tanks for underground Storage" in Section 46, change flash point at top of both columns of table from 150° to 100° F. and in second sentence of paragraph *g* change word "closed" to "enclosed."

Electrical Committee.

A meeting of the Electrical Committee N. F. P. A. was held in New York City on December 5th and 6th, 1921, not for the purpose of passing definitely upon changes in the National Electrical Code but, as stated by Chairman Dana Pierce, with the object of determining ways and means for putting forward the committee work. No public hearings were held at this session as is the case when the committee is assembled for formal revisions of, or amendments to, the Code. The meeting for this latter object is to occur in November, 1922, at which time the reports of the various standing committees charged with investigations of special subjects are to be considered and amendments to the code as advocated by the Electrical Committee adopted. At the conclusion of this meeting a bulletin is to be issued setting forth the changes adopted and announcing a public hearing in March, 1923, at which persons having objections to these changes will be heard. The Electrical Committee will then consider and take final action on the points brought out at the public hearing in March and the revised edition of the Code as of 1923 will be issued.

Respecting the technical sub-committees it is intended that national associations interested shall be very broadly represented thereon in order that the greatest field experience may be available to the Committee, and it was pointed out by Chairman Pierce that members of these sub-committees representing national associations are expected to express not only their own ideas on any subject considered but the opinion of the associations with which they may be connected. With the object of pro-

viding some medium through which new electrical inventions, methods or systems might be considered and the necessary field experience obtained, it was decided to create a special committee for this purpose composed of the chairmen of the present ten standing committees and the chairman of the Electrical Committee. The chairmen of the standing committees were asked to consider accident as well as fire safeguards in the work of revising the National Electrical Code and it was voted to appoint a sub-committee of five to prepare a recodification of the Code.

Forms of reports and procedure of standing committees and technical sub-committees were discussed and adopted. (For a statement of the functions and responsibilities of these committees see report of Electrical Committee to annual meeting 1919, *Proceedings* p. 154.) Various technical matters presented were referred to the appropriate sub-committees for consideration.

The Inflammable Picture Film in Texas.

Film Exchange Explosion and Fire in Dallas, Dec. 10, 1921.

A quarter of a million dollars was added to the already stupendous fire waste of 1921, and assessed by the motion picture industry upon the people, by a film exchange fire on Commerce St., Dallas, Texas, on the evening of December 10, 1921.

The exchange was located in a building neither designed nor suitable for so hazardous an occupancy, being of ordinary brick walled, wood joisted construction with unprotected cast iron columns and steel I-beam girders. There was an open stair and elevator in the section where the first explosion occurred. Film vaults had been provided but no attempt had been made to comply with the regulations for their proper ventilation. Without exception the films were stored without containers; in one vault being on spools stored in piles.

The cause of the fire could not be determined, the first indication being an explosion. A fire captain from the central station, two and a half blocks away, passed the building just before the explosion occurred. He ran to avoid injury and escaped with scorched hair. A dozen buildings and their contents were wrecked or injured by the explosion and following fire and water, and of ten automoblies parked in the area affected by the fire, most of them were a total loss. When the fire apparatus reached the scene of the fire the trolley and power wires were already down with the consequent handicap to the firemen. The latter did not dare to enter the film exchange building. The water throwing was from the outside.

The rarest good fortune attended this fire, which would assuredly have taken a heavy toll of life if it had not occurred at night when the employees were out of the building. At the moment of the explosion (about 9:45 P. M.) no street car nor auto was passing, and no pedestrian, except the fire captain, who had passed the point of maximum danger.

There is no trouble in placing the responsibility for this fire. The estimated loss of $250,000 should be borne by the motion picture industry,

The motion picture film explosion and fire in Dallas, showing effect on substandard storage vaults and building.

which in the location and conduct of this exchange so violated considerations of safety. The assessing of this quarter of a million dollars loss upon the people is an economic wrong made possible only through public ignorance. A heavy loss of life, escaped in this fire through the merest chance, would have placed an embarrassing moral responsibility upon the owners. It is this hazard, of which the professional handlers of nitrocellulose film who know its dangers are often so oblivious, that is persistently making its way into non-professional use, in churches, lecture halls, and schools. It is possible to print motion pictures on a film that will render them harmless both in storage and in use. Public opinion will eventually demand this safety film even for professional purposes—or will compel the motion picture industry to pay the bills inflicted upon the public by such heavy losses and potential holocausts as this in Dallas.

"Sconset Chemical No. 1"

This photograph by George B. Muldaur (Member N. F. P. A.) was taken at Sconset, Mass., last summer. He says: "The amusing part of this picture is the bunch of wild carrot growing directly in front of the door, which at least shows that the Fire Department has not been called on very frequently of late I have not been able to learn who the Department is or where he lives, but doubtless he will be on hand when the time comes."

The Protection of Historic Public Buildings.

3. Washington's Mount Vernon Home.*

By Carlyle H. Hill.
(Member N. F. P. A.)

Mount Vernon, the home and tomb of George Washington is not only a shrine to be visited for its patriotic and historic interest, but likewise for its justly famed charm and beauty that is now being so faithfully preserved. This article deals with its preservation from fire, fire hazards, and fire possibilities.

The estate, which originally consisted of a tract of 5000 acres, is situated on the west bank of the Potomac River in Fairfax County, Virginia, at a point about 15 miles south of Washington, D. C. Little Hunting Creek Plantation, as it was once called, had been in the Washington family for several generations, when George Washington first resided there at the age of sixteen. At that time the estate belonged to his half brother, who had built the original dwelling in 1743. The estate became his after the brother's death in 1752.

Washington married in 1759 and became established at Mt. Vernon, living there and cultivating the plantation for fifteen years. In 1775 he enlarged the mansion to its present dimensions by additions at each end of the original dwelling, erected several of the out buildings and walls, and beautified the grounds in accordance with his own plans and specifications. During the period of the Revolution, his duties of course kept him away from Mt. Vernon, but his wife, Martha Washington, maintained the estate during his absence.

On April 14, 1789, it was at Mt. Vernon that Washington received the official announcement of his election as President, and after the completion of his second term it was to Mt. Vernon that he retired. He caught a severe cold while riding on the estate during a storm, and died there on December 14, 1799. Martha Washington lived on at Mt. Vernon until her death on May 22, 1802. Their bodies were placed in a tomb by the house, but in 1831 were removed to a vault a short distance away.

After Washington's death, the property remained in the family until 1858 when it was sold to the Mt. Vernon Ladies' Association, the present owner and curator. Through the efforts of this Association of patriotic women, Mt. Vernon was gradually restored, not only the buildings and grounds, but in the furnishings of the mansion and its attendant buildings. Although some of the furniture is contemporaneous, a great part of it and many of the household features and personal effects are the originals used by Washington. These highly interesting articles have

NOTE:—This is the third of a series of articles on the fire protection of important public buildings of historic interest. The fourth will appear in an early issue. —Ed.

Washington's Mt. Vernon home overlooks the Potomac River, fifteen miles south of Washington, D. C. It is estimated that in case of fire here it would be forty minutes before the nearest public fire department could get streams in action.

been secured through persistent efforts to the end that the restoration of each feature as it existed in the days of Washington may be entirely authentic and complete.

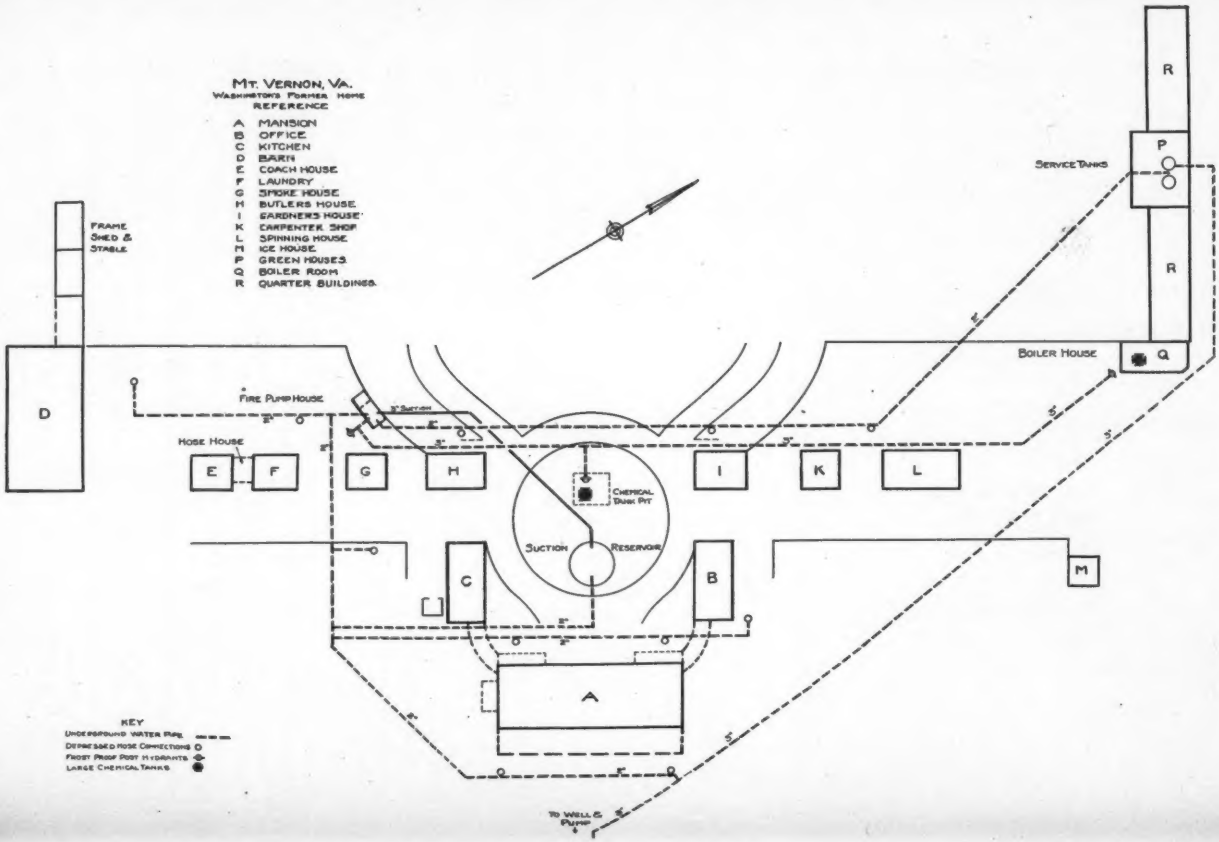
The preservation of the buildings, furnishings and grounds requires a great amount of care and as a considerable expenditure is necessary each year; it is interesting to note that an entrance fee of 25 cents paid by visitors constitutes the principal source of revenue.

Fortunately Mt. Vernon has been free from accident by fire since the time of Washington, due in no small part to the efficient surveillance of its guardians and therein lies its sole safety from destruction by fire. Beyond the reach of public protection, these buildings are wholly dependent upon the facilities at hand, the value of which may be gathered in the following description.

Construction.

The mansion is a two story and attic structure entirely of wood on stone and brick foundation with basement under the entire length. The framework is oak with a sheathing of pine, paneled and sand coated to resemble stone. A portico extending the full length on the east side is supported by eight wooden columns reaching a height of two stories. The interior finish, including the attic, is ordinary wood lath and plaster, the partitions are hollow on four inch studding and a large central hall contains an open stairway extending from the first to second floor. The roof is covered with ordinary wood shingles without under protection. Considerable work has been done in the way of reinforcing foundations and other supports.

On the west front is a grass court flanked by several frame buildings; on the south side of this court is the kitchen and on the north side


MT. VERNON, VA.
WASHINGTON'S FORMER HOME
REFERENCE
A MANSION
B OFFICE
C KITCHEN
D BARN
E COACH HOUSE
F LAUNDRY
G SMOKE HOUSE
H BUTLERS HOUSE
I GARDNERS HOUSE
K CARPENTER SHOP
L SPINNING HOUSE
M ICE HOUSE
P GREEN HOUSES
Q BOILER ROOM
R QUARTER BUILDINGS
FRAME SHED & STABLE
FIRE PUMP HOUSE
HOSE HOUSE
SERVICE TANKS
BOILER HOUSE
CHEMICAL TANK PIT
SUCTION RESERVOIR
TO WELL & PUMP
KEY
UNDERGROUND WATER PIPE
DEPRESSED HOSE CONNECTIONS
FROST PROOF POST HYDRANTS
LARGE CHEMICAL TANKS

the office, one story and attic, wood buildings, with wood shingle roofs. These buildings are located about 25 feet from the mansion but are connected with it by wood colonnades that would afford an excellent opportunity for fire originating in either of these buildings to communicate with the mansion. Farther detached to the west and flanking the court are groups of small one-story frame buildings; those on the south comprising the butler's house, smoke house, laundry and coach house, while to the north are the gardener's house, carpenter shop and spinning house.

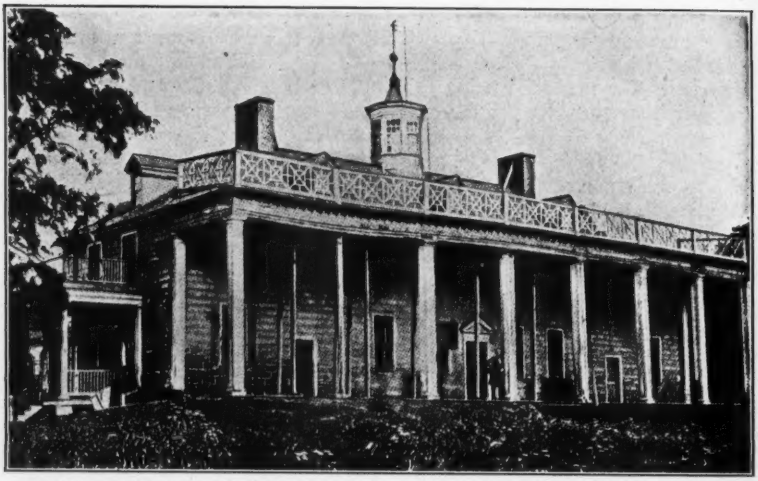
The barn, a one and a half story brick structure with shingle roof, is located at a comparatively greater distance to the south, while at some distance to the north are the brick greenhouses and former servants' quarters with a small brick addition containing the heating boilers. A semblance of the relative location of the various buildings may be had by reference to the accompanying plan.

Occupancy.

A number of the mansion bed rooms are used for a short period annually when the Mt. Vernon Ladies' Association Council meets, but it is otherwise unoccupied and is open to visitors week days only. Former servants' quarters (R) on either side of greenhouse and a large part of the spinning house (L) are also fitted as dormitories for the Council's use. The office (B) is used by superintendent for office and dwelling purposes and part of the kitchen (C) is used for cooking. The butlers' house (H), laundry (F), gardener's house (I) and upper floor of kitchen are equipped as sleeping quarters for employees. The smoke house (G) is used for fuel storage and coach house (E) contains a large coach of historical interest. A part of the kitchen and spinning house also contain relics identified with these buildings. The greenhouse is used in part for miscellaneous storage. The barn (D) is used for storage of old lumber in the loft, carriages and tools being in separated sections on the ground floor. Horses were kept here until recently but have been removed together with hay, etc., to small temporary frame stable constructed for the purpose at the west end of an open shed adjoining the barn. This is to be replaced in the near future by a stable well detached from the historic buildings. An addition (Q) to the quarters (R) contains the heating boilers, coal and portable chemical tanks.

Heating and Lighting.

At one time the mansion was heated by a hot air furnace located in the cellar, but this has been abandoned for a far safer method. Two low pressure heating boilers in an addition to the quarters now furnish the heat for a system of hot water radiators installed in the cellar of the mansion, from which heat is conducted to rooms and halls above through metal ducts and registers. The arrangement of the boilers, however, cannot be considered entirely safe. They are set below ground level and a large metal flue passes in the rear to a substantial brick chimney; directly over the boilers, however, is an old loosely constructed wood floor, the rear portion of which is cut away where the flue passes for its length at the same level. Workmen and gardeners have access to this room and



When viewing Mt. Vernon today, especially the Mansion, it seems hardly possible that at one time this historic building could have presented such an appearance of neglect as is evidenced by this photograph, which was taken prior to its restoration in 1860.

the floor and surface of the flue itself are susceptible to accumulations of inflammable material. It is understood that steps are to be taken to remedy this condition, probably by removal, or substitution of a fire resistive floor. A corrugated iron roof on wood supports extends beyond the heater room over a bin containing the coal, and a communication exists with the adjoining quarters and greenhouse through small openings in a brick dividing wall. Although this group is well detached, a fire originating here might result in considerable damage, not only to these buildings and their contents, but subsequently through impairment of the water supply system, connections to which are exposed in the rear of the greenhouse where supply and discharge pipes are connected with elevated tanks.

Lighting arrangements are provided for the mansion and a large part of the dormitories only when the Association Council meets and only electric lights are used in any of the buildings. Those of a permanent nature are supplied with current from a low voltage generator battery system located in an addition to the pump house which is safely detached and well arranged. Current is generated at 32 volts and system was apparently installed in an entirely satisfactory manner. Dormitories that are occupied only periodically are lighted by use of portable batteries and electric lamps, constituting a safeguard that can hardly be improved upon. All buildings have been equipped with lightning rods.

Open fire places are prevalent throughout the buildings but chimneys have been closed and these are no longer used. The only other fires, aside from the heating boilers, consist of a small safely arranged coal stove in the sleeping room in laundry building and a large coal range in

Photograph by William S. Boyd (Member N. F. P. A.)

Rear view of Mt. Vernon mansion, showing connecting additions. These buildings all have shingle roofs and a fire in any one of the several outbuildings would be apt to seriously expose the mansion proper.

the kitchen. This range is set on cement floor and otherwise appears properly safeguarded with one exception; the metal flues lead to a brick chimney that at one time was supported on a large brick base. This was later changed, however, and the brick chimney now extends only through the roof and down to the ceiling level of the first floor, being supported at this point by a short wooden beam on a wooden column. The column is metal covered to a certain height and the metal flues are asbestos wrapped. Owing to the heat evolved at times, however, and the very small clearance between flue and wood column the arrangement cannot be considered satisfactory. It is understood that fires in the kitchen and laundry are to be discontinued in the near future.

Smoking by either employees or visitors is of course prohibited, not only in the buildings but anywhere upon the premises and regulations in this respect are rigidly enforced.

Two watchmen are on duty from 9 P. M. to 6 A. M. Half hourly rounds are made by these men alternately, registering on a portable clock from six stations on the outside of the buildings.

From seven to ten guards are on duty during the day and these men with their families occupy dwellings or quarters on the estate.

Fire Protection.

Fire protection at Mt. Vernon as elsewhere in Washington's time consisted principally of the "bucket brigade system." That Washington was prepared to fight fire is evidenced by the "Leathern" buckets bearing his name now displayed in the mansion as relics, and the roof ladders, duplicates of which may now be seen in place on the roof.

To provide Mt. Vernon with modern appliances for fire extinguishment, without projecting the modernism of such equipment upon a scene otherwise congruous, has been no small problem. Consistency with the general scheme must be preserved and unfortunately modern appliances, regardless of value, must have their effectiveness diminished to the extent of concealment. To provide such appliances and improve upon them as occasion permits has been the aim of the Association.

The nearest public fire department is at Alexandria, about 8 miles distant, and although equipped with motorized apparatus it is conservatively estimated that at least forty minutes would be required before pumpers could be used to advantage. Engines would be compelled to take suction from the Potomac River, the nearest point being 600 feet distant and 125 feet below the level of the mansion. At present, destruction by fire can be prevented only by extinguishment before it has passed the incipient stage. Fire would spread with great rapidity if not detected and checked at the start and the use of heavy streams may only be successful in saving a small part of the mansion should fire of large proportions occur in that structure. The value of such streams, however, from another standpoint cannot be over estimated. The proximity of the kitchen and other out buildings, combined with the prevalent shingle roofs, may conceivably result in an exposure fire of such degree that heavy hose streams would prove the only barrier against loss of the mansion. Large quantities of water would be needed in this event, not only to extinguish the fire but to cover the mansion with a protecting blanket.

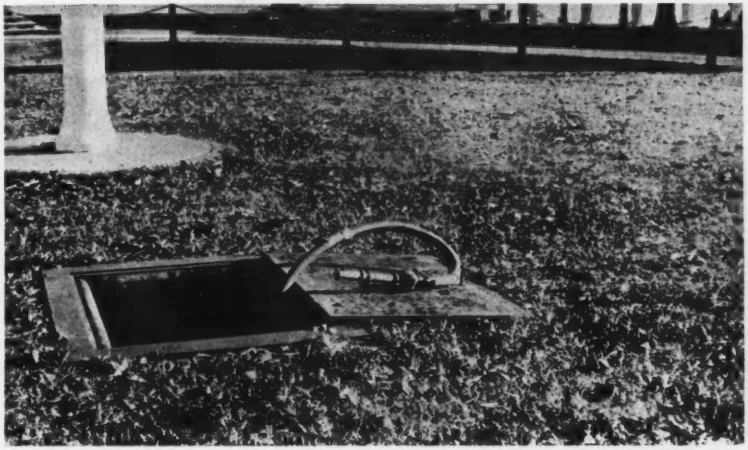
Until 1885 the protection was furnished only by a battery of stationary hand pumps connected with 2 inch pipes and small hose connections but this system has been improved upon from time to time and chemical equipment added. Briefly outlined the protective apparatus today is as follows:

A number of 2½ gallon soda-acid extinguishers of the loose stopple type are distributed about the premises. The kitchen, barn, greenhouse and gardeners building each contain one and one is located on each floor of the mansion.

A chemical equipment is provided as follows: two 100 gallon tanks on wheels, each with 50 feet of hose and nozzle attached are located in the boiler house, an additional 100 feet of hose is provided but is not attached. Two 100 gallon tanks of the stationary type are set in a large concrete pit in court yard about 80 feet west of the mansion. A 100 foot length of hose is attached with nozzle fastened to hook and easily accessible by opening hinged cast iron cover. Hose is coiled on the floor and edges of the pit opening are provided with rollers to facilitate the running out of hose. An additional 100 feet of hose is coiled in reserve but is not attached for immediate use.

The small extinguishers bear tags with last charging dates as far back as 1914, but it is stated that all extinguishers including the large tanks are recharged semi-annually. One of the hand chemicals inverted for test purposes was found to operate satisfactorily.

The water supply for domestic and fire protection purposes is furnished by a 4 in. x 6 in. triplex pump driven by either a 500 volt trolley current motor or a kerosene engine. Equipment is located in a concrete



Part of the fire protection equipment, a pit in the court yard containing chemical tanks. There is sometimes considerable snowfall in this part of Virginia.

vault near the river about 600 feet east and 125 feet below the level of the mansion. Pump has a capacity of approximately 75 gallons per minute and takes suction from an artesian well or in emergency from the river; discharge is through a 3 inch underground pipe to service tanks in the greenhouse. Underground reservoirs, the principal one of which is located in the court yard, and having a total capacity of 35,000 gallons are used as the suction supply for fire pump. These reservoirs are kept filled by means of the supply pump at river, normally through the service tanks mentioned above or by operation of valves directly through 2 inch underground connections.

To furnish small hose streams an underground system of 2 inch pipe is provided with a number of 1½ inch hose connections at points indicated on the accompanying plan. These are equipped with valves and are brought to a point near ground surface in terra cotta boxes topped with cast iron covers. The system is supplied by direct pumping from a 5 in. x 8 in. triplex pump taking suction from the 35,000 gallon reservoirs. The pump has a capacity of about 175 gallons per minute and is driven by a 10 horse power gas engine using kerosene. This equipment, together with electric generator which is in a separate compartment, is located in a small detached brick building west of smoke house. Floor is cement and roof corrugated iron on wood supports.

This pump also discharges through a separate 3 inch line to three small frost proof post hydrants, one located near the pump house, one at the boiler house and one in the court yard pit. The connection for direct filling of the suction reservoir is a part of the 2 inch small hose system and could be used for this purpose while permitting the fire pump to discharge to the separate 3 inch hydrant line, the three hydrants on which are fitted with 2½ inch and 1½ inch hose connections.

All hose for small connections and hydrants is kept in an open frame shed between the coach house and laundry and consists of but 100 feet of 2½ inch cotton rubber lined hose with ⅝ inch nozzle and 250 feet of 1½ inch cotton rubber lined hose with ½ inch and ⅝ inch nozzles; an additional 150 feet of the small hose is at other points on the premises but no hose reels or carriages are provided.

From 10 to 12 men, exclusive of the Superintendent, his assistant and the Engineer are on the premises daily and although familiar with the fire apparatus and pumps they are not regularly drilled as a fire brigade. A number of these men and their families occupy dwellings on the estate located approximately 1000 feet from the mansion, and in addition to the two night watchmen, six men occupy quarters in buildings adjacent to the mansion.

In case of fire, alarm is sounded by ringing a large bell hung in the summer house and a specified signal is used. This bell can readily be heard on all parts of the estate and would undoubtedly attract assistance from points beyond. There are telephone connections provided by which public fire department aid may be summoned.

At the last annual meeting of the Association provision was made for substantial improvement in the water supply through larger mains and increased pumping facilities and this work is to be accomplished within the present fiscal year, ending April 30th, 1922.

The Mt. Vernon Ladies' Association and those charged directly with the care of Mt. Vernon, appreciate better than anyone the necessity of fire prevention and protection for this isolated property and they will undoubtedly make improvements in accord with modern methods to the extent that their means and circumstances permit, and it is their desire that in time Mt. Vernon will be as safe from fire as it is as possible to secure through the employment of modern equipment and human endeavor.

American Engineering Standards Committee.

Its Organization and Work.

Among those taking an active interest in the standardization work of various technical societies, there was evident, for a number of years, the need for closer co-operation in order to prevent duplication and the promulgation of conflicting standards.

This sentiment finally crystallized in the appointment of a committee by the American Society of Civil Engineers, American Institute of Mining Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers, and the American Society for Testing Materials. The first meeting of the Committee was held January 17, 1917. The problem was to formulate some plan that would be effective without interfering with the work of the many organizations that had been and were doing such excellent work in this line.

The first plan contemplated a committee made up of representatives of the five societies mentioned; later, the Government Departments of War, Navy, and Commerce, were invited to join, and did so; still later, the constitution was broadened to permit the representation of other bodies on the Committee. The present plan of organization and work is the result of long and painstaking study and discussion of the subject by the many bodies interested.

Objects.

The objects of the American Engineering Standards Committee briefly stated are:

To unify methods of arriving at engineering standards, to secure co-operation between various interested organizations in order to prevent duplication of work and promulgation of conflicting standards.

To receive and pass upon recommendations for standards but not to initiate or develop the details of any particular standard.

To act as an authoritative channel of co-operation in international engineering standardization.

To promote in foreign countries the knowledge of recognized American standards.

To collect and classify data on standards and standardization bodies in the United States and foreign countries, and to act as a bureau of information regarding standardization.

Organization and Procedure.

1. The Committee proper, the "Main Committee", is primarily an organizing, co-ordinating and steering committee, and does not define or develop details of any particular standard.

2. Sectional committees are committees—one for each standard or group of standards—whose function is to prepare the standard, or standards, under direction of the most vitally interested organization, or organizations, known as sponsor.

3. The sponsor is a co-operating organization (or group of organizations), approved by the Main Committee, to organize and direct a sectional committee, for the development of any standard or group of standards. It is not necessary that a body be represented on the Main Committee in order to act as a sponsor.

4. Any standard or group of standards adopted or in process prior to January 1, 1920, may be approved by the Main Committee, if, in the opinion of the Committee it has been developed by a properly constituted committee, or has by actual practice proven its right to become a standard.

5. When the development of a particular standard or group of standards is proposed, the Main Committee assigns the work to the appropriate organization (or organizations) as sponsor.

6. The sponsor then appoints a sectional committee, subject to the approval of the Main Committee. The purpose of the approval is merely to assure the comprehensive representation of all interests involved. Fundamentally, the degree of success of any standardization work depends on the comprehensiveness of the representation on the committee developing the standard; in other words, the more broadly comprehensive the representation on the committee, the more broadly will the standard be accepted.

7. A sectional committee dealing with standards of a commercial character (specifications, shop practices, etc.) must be made up of producers, consumers, and general interests—no one of which shall form a majority.

8. After a standard or group of standards has been prepared and approved by a sectional committee, it is submitted to the sponsor for its approval, and then to the Main Committee with its full history. Upon approval by the Main Committee, it becomes an "American Standard," a "Tentative Standard," or a "Recommended Practice," according to circumstances and the nature of the standard.

9. The scrutiny of a standard by the Main Committee is to make sure that the proper procedure was pursued, that the vote of approval was approximately unanimous, and that the standard is consistent with other standards—the Main Committee not to pass upon the details.

10. After approval by the Main Committee, the standard is published by the sponsor under appropriate title, and over the statement "Approved by the American Engineering Standards Committee."

It is thus to be seen that the "approval" of a standard by the American Engineering Standards Committee does not mean that the Committee has itself worked over and approved each detail, but rather that the work has been carried out by a sectional committee adequately representing the industry concerned, and sponsored by one or more bodies of experience and standing, so that the result may stand for what is best in American engineering practice.

The Fire Protection Group.

Immediately after the broadening of the Constitution to permit membership by other bodies than the founders, the Fire Protection Group was organized and application made for representation upon the Committee. This group member is composed of the National Board of Fire Underwriters, the Associated Factory Mutual Fire Insurance Companies, The

Underwriters' Laboratories and the National Fire Protection Association. The three representatives of this group member upon the "Main Committee" are Dana Pierce, Vice-President of the Underwriters' Laboratories, Ira H. Woolson, Consulting Engineer of the National Board of Fire Underwriters, and H. O. Lacount, Chief Engineer of the Factory Mutual Companies, all prominent members and Committee Chairmen of the National Fire Protection Association. Dana Pierce is the representative of the group upon the Executive Committee of the A. E. S. C.

Up to the present time but one set of N. F. P. A. standards has been officially submitted to the American Engineering Standards Committee; this is the National Electrical Code, edition of 1920, which has been formally accepted and registered under the established rules of procedure as an "American Standard." It is the purpose of the Fire Protection Group to eventually submit the entire list of N. F. P. A. regulations for such registry.

The Fire Protection Group has been recognized further by the selection of the National Fire Protection Association as sponsor or joint sponsor for other standards now in process of formation the responsibility for which has been accepted by the N. F. P. A. executives. One of these is the sponsorship for a "Building Exits Code," now under the direction of the N. F. P. A. Committee on Safety to Life, H. W. Forster, Chairman, which is evolving such a code with the assistance of various bodies organized as a sectional committee. The report of this Sectional Committee when its work is completed will be presented to the N. F. P. A. by the Committee on Safety to Life to be adopted by the Association and subsequently recommended for adoption to the American Engineering Standards Committee, its acceptance by which will discharge the sponsorship of the N. F. P. A. for this important item.

The N. F. P. A. has also accepted joint sponsorship with the U. S. Bureau of Standards for an "Electrical Fire and Safety Code" with the understanding that the acceptance of such joint sponsorship for such a code does not commit the Association to discontinuance of the National Electrical Code (Fire). The N. F. P. A. will naturally function in this work through its Electrical Committee, Dana Pierce, Chairman, which is already in conference with the Bureau of Standards in the matter.

Beside these direct sponsorships the National Fire Protection Association is frequently requested by other sponsors to participate as members of sectional committees in the evolution of standards in which the N. F. P. A. has a secondary interest or can render assistance. Such a standard is the proposed "National Gas Safety Code" sponsored jointly by the American Gas Association and the Bureau of Standards. F. J. T. Stewart of the N. F. P. A. Committee on Gases is the official representative of the Association on the sectional committee administered by these sponsors. Another such illustration is the proposed "Safety Code for Lightning Protection" sponsored jointly by the Bureau of Standards and the American Institute of Electrical Engineers. On the sectional committee created by these sponsors, the Association is represented by A. M. Schoen, chairman of the N. F. P. A. committee on this subject.

Motion Picture Production Hazards.

By V. L. Benedict.
(Member N. F. P. A.)

The tremendous growth of the motion picture industry has been one of the commercial marvels of the past decade. As in many other instances America furnished the genius which founded and developed the motion picture. The experiments of Muybridge on the motion of race horses, the inventions of Edison and Jenkins which developed into the modern projector, and the pioneer work of Eastman with flexible film, stand out in the history of this remarkable industry. It is an interesting record of achievement.

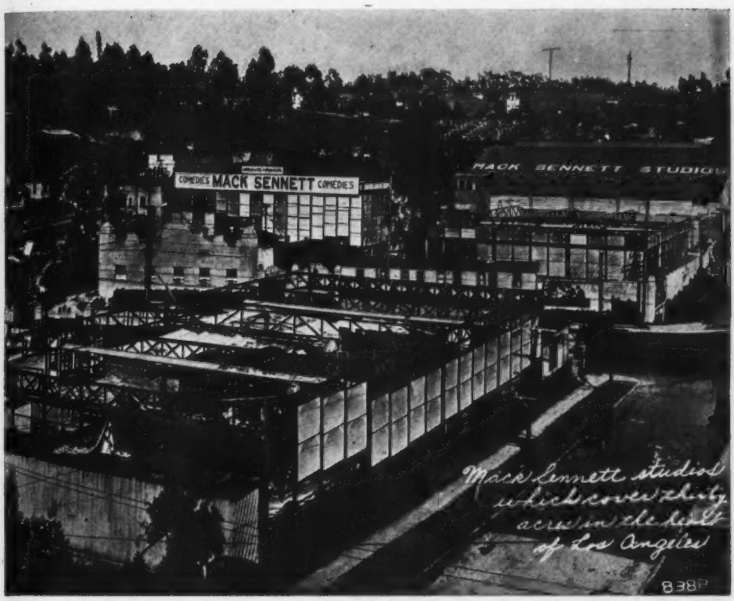
As has been the case with most new rapidly growing industries, there has been a period when the development of safeguards has not kept pace with the creation of new hazards. Motion picture film, as far as strictly professional use is concerned, is beginning to emerge from this period, though there are still many film fires. When proper precautions are observed such as recommended by the National Fire Protection Association in the regulations promulgated by the National Board of Fire Underwriters for the storage, handling and use of film, the danger from film fires is minimized. From the standpoint of the motion picture producer, however, more careful safeguarding may be necessary, for while the regulations are primarily concerned with safety from fires caused by film, the motion picture producer is concerned with the safety of the film itself, for exposed negative film is one of his assets which sometimes can not be duplicated except at enormous expense and after months' delay.

While the film is regarded as the first hazard of the motion picture industry, the rapid development of large scale production has introduced other studio hazards which are treated in some detail in this article. In the East, where climate demands substantial construction, studio buildings are usually comparable to mercantile or manufacturing construction, and often have automatic sprinklers or are of fire resistive construction. In California, however, "where the movies are made," climate does not require substantial construction, and conditions are different.

This article is written with particular reference to the hazards found in the California studios, though obviously many of the points made will be applicable also to Eastern studios.

Motion Picture Film.

A review of the hazards of the motion picture industry necessarily begins with the film, the best known and most prolific source of fire hazard. Film hazards and film fires have been the subject of articles in previous issues of the quarterly and of N. F. P. A. Committee reports; it is, therefore, unnecessary here to do more than briefly mention the more salient features.



A typical studio of Southern California, showing clearly the type of construction. The building at right in the background is of reinforced concrete. Other structures are of wood, canvas, and corrugated iron. Note, also, the wooden sets on the hills in the rear and the pile of rubbish at the left of the studios.

Motion picture film is a cellulose nitrate product of a low degree of nitration. Contrary to popular impression, film is not explosive but when ignited, burns rapidly with a yellow flame, emitting, where there is good air circulation, little or no smoke. Film is stable at ordinary temperatures, but under certain conditions of storage, particularly in the absence of free circulation of air, decomposition may start at the comparatively low temperature of 300° F. Decomposition is more to be feared than combustion because of the generation of a dense yellowish gas which, if confined and mixed with air, may ignite and explode.

To meet the demand for a non-flammable motion picture film, the cellulose acetate film was developed. This film is practically non-flammable, being on a par with ordinary paper. It does not decompose under 500 to 600° F. while standard film decomposes at 300° F. It does not evolve explosive gases while decomposing or burning, and does not contain internal oxidizing agents to produce combustion of the rapid and persistent character of the nitro-cellulose film.

A special width and style of perforation has been adopted for the cellulose acetate film, and the manufacturers do not cut nitro-cellulose film to this special width. This eliminates possibility of the inflammable film being used in error for non-flammable film. The safety film also has distinguishing marking on the margin at short intervals.

An example of unsafe conditions in a film inspection room. Note the large amount of film on hand, the film at left, not in containers, and the open waste baskets. This is a typical room, with conditions not nearly so bad as they might be if the floor were littered with film scraps.

The cost of the safety film is greater than the standard film, and its durability and efficiency are not as high. It is to be hoped that the skill of the manufacturer may yet evolve a safety film of equal excellence to the nitro-cellulose film, at a cost which will permit universal adoption, thereby ending danger to life and property from film fires.

Film Storage.

The greatest concentration of values and of material sufficient for a severe fire, is the storage of the film. Exposed negative film often represents the efforts of thousands of players, or the use of scenes impossible of duplication without great expense. Exposed positive film, which is printed from the negative for distribution to the trade, is also of great commercial value. At one studio, in a two-story vault structure, some fifteen feet square, $3,000,000 insurance was carried at one time, and the vaults were not equipped with automatic sprinklers. Such placing of eggs in one basket, however, is unusual, and as new storage vaults are built, sprinklers are provided.

Size of vents is a most important feature. While vaults of more recent construction usually have openings of sufficient area, older vaults often have vents which later experience has shown to be inadequate in case of fire. The lack of sufficient ventilation caused explosions, which partially wrecked two buildings in Pittsburgh a few years ago. The gases of decomposition should be carried away before mixing with air in ex-

plosive percentages. Pressure in the vault also contributes toward forming explosive mixtures.

Another point worthy of mention in connection with vents is that burning gases from a film vault fire may be of great volume, and would blanket any fire escape near or above the vent. Consequently such fire-escape should be disregarded as a means of exit if within twenty-five feet of the vent.

Experience has shown that on account of the high value of negative film, it is preferable to have individual vaults separate from other buildings and in a different section of the studio from vaults containing positive film. The problem in this case would not be to protect other sections from film fires or explosions, but to safeguard the film itself. While automatic sprinklers are successful in controlling film vault fires, the damage to the film through water may be very great. Film is liable to stick together if wet, unless quickly unrolled and submerged in water.

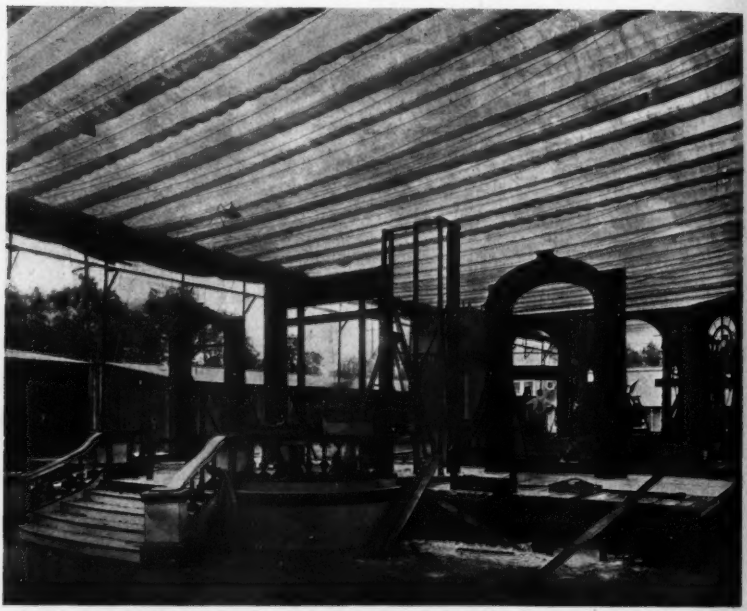
Each container should have a maximum of 2000 feet of film, and each should be preferably in a separate compartment and placed in a horizontal position. No containers should be less than 12 inches from the floor, and ample water drains should be provided. The capacity should not exceed 750 cu. ft., for which would be required at least 12 sprinkler heads, while 18 heads would be preferable. The tiers of the containers should be separated by asbestos board or equivalent insulation.

Mr. Roy H. Klaffki has designed vaults of novel characteristics for the Metro Pictures Corporation, Los Angeles. He uses a horizontal position of the standard container, with single tiers twenty-two cans high. The water from an open sprinkler, after cooling the top can, falls through the open central portion of the shelf upon the next lower can, and so in turn cools all the cans in that tier. In addition to keeping the film dry, this method obviates any draft up through the can, which in a vertical position might occur if the cover were not a tight fit. Experiments have indicated the advantages of this method, which will protect large values.

The danger of adjoining outlets for the vents of two vaults was clearly shown by the Kansas City Film Exchange Building fire, July 23, 1920. A new fire-resistive building, especially designed for the purpose, had a severe fire with accompanying explosion. The fire spread from one vent back into the adjoining vault and also through the next window, about three feet distant, back into an examining room, and from there to the shipping room. The automatic sprinklers had not yet been installed, and the great bulk of film was not in containers.

Studio Construction and Protection.

While the matter of film hazards and protection has received much study and thought, the various points of hazard in the producing end of the business have not received a similar amount of attention. Of these the important features are construction and protection of buildings and stages, and the safeguarding of carpenter shops, dressing rooms, property storage, etc. In connection with motion picture production there is a large amount of carpenter work and painting which involve hazards the extent of which would not be realized by one unfamiliar with the industry.



Construction of a large set in the Paramount Studios. The large amount of wood and canvas makes fire protection a difficult problem. Note canvas curtain ceiling.

Because of the mild climate of Southern California, construction is usually simple. For the stages a steel skeleton, with roof and walls of glass is usual. For the "dark stages," an interior of heavy timber or mill construction, with exterior of frame or corrugated iron is often employed. Dressing rooms, property rooms, carpenter and paint shops, and other departments are in many cases of frame construction, with exterior of plaster or corrugated iron.

In numerous instances, growth of studios has been so rapid that resultant congestion of buildings has involved serious exposure hazards.

In general, little consideration has been given to fire walls or other protective features of permanent substantial construction during the mushroom growth of studios. Much of the building is necessarily of a temporary nature where anything but cheap construction would be out of the question.

There are many preventive and protective measures which should be adopted, although few of these are found in the average studio today. The danger of exposure fires should be eliminated as far as possible by suitable distances between buildings and by fire resistive construction. A corrugated iron exterior, such as is often seen in studio construction, is of practically no protection to combustible material on the inside near the wall, as heat passes through the iron and easily ignites adjacent material.

An outdoor set built on an open stage in the Christie Studio. Such construction near a studio building constitutes an exposure hazard. Note that the camera man is smoking.

Water curtains may be considered advantageously where large buildings, housing shops or stages are crowded together, without adequate fire stops. While private fire departments, with efficient fire drills, may afford a measure of protection during working hours, a night fire would find but a handful of employes available to use the protective facilities of the studio. Under such conditions several, if not all, of the buildings could be involved, and an effective water curtain might be the only barrier to prevent severe loss.

Sub-division of buildings to confine a fire in the section of its origin has been demonstrated to be of great value. The cost of metal lath and plaster or equivalent partitions is small, yet they may prove the safeguard which prevents destruction of the property. Fire doors of approved type are of great value in holding a fire in check.

Wired glass windows in metal frames will often effectively check an external fire. They should be incorporated in new construction where exposed at present or liable to exposure in the future.

Undoubtedly the most effective of all fire fighting facilities for the studios is the automatic sprinkler. The equipment of a plant with a sprinkler system either entirely or in part is worthy of careful consideration.

A substantial water main for a large plant, of at least six inch diameter with liberal distribution of hydrants and hose reels, may be con-

sidered necessary. Frequent hydrant tests are advisable, particularly in cold weather. The value of vigilant inspection was illustrated recently when a studio had put in a loop of six inch mains and several weeks elapsed before it was discovered that no water had been turned into the mains. The water supply had not been applied for at the city water office.

Watchman service and plant fire alarm systems are generally employed. They are, of course, valuable.

It speaks well of the housekeeping of motion picture producing plants that comparatively few fires occur, and the fire loss has been so moderate. However, few if any executives of motion picture producing plants can feel immune from serious fires. The greatest fire in the industry was that of the Thomas A. Edison plant, Dec. 9, 1914, starting in the film testing department, with a loss of $2,000,000. With such disaster possible to a group of concrete buildings, the question of adequate defense against serious damage to production and to property should have the unceasing attention of the management of every motion picture producting plant.

Stages and Sets.

For some years open stages covered with canvas sheets, which are adjustable to secure varying lighting effects have been in general use. The present tendency, however, is to glass in the open stages on account of rain and moisture, retaining the canvas sheets under the glass roofs.

Stages are large enough to permit several companies to work at one time. At one studio, the stages are 78 by 112, 70 by 61, 90 by 185, 72 by 250, and 84 by 253, with a swimming pool and garden adjoining.

The quantity of material in sets is large and involves heavy expense; housekeeping is correspondingly important. For example, one spectacular set cost $25,000, yet was shown on the screen for but a few seconds. The electrical system is elaborate, both for lighting and for remote control of equipment. Since the wiring is in accordance with usual standards, little trouble is experienced from this source.

Material used in sets is generally combustible, presenting considerable fire hazard which fortunately so far has caused but small damage. Because of the high roofs of stages and the fact that many sets are roofed over, automatic sprinklers would possibly be unable to control fire on the stages, and are not generally used. Experience may demonstrate the wisdom of providing sprinklers on stages.

A point that is not always recognized is the exposure to permanent buildings from disused sets. These often comprise whole streets or even villages set up to represent some familiar location. They are constructed largely of wood and in many cases, particularly if land is cheap, are left to rot rather than going to the trouble of tearing them down. Unless these are well detached from other buildings, there is a constant conflagration danger.

A large investment is represented by the lighting equipment, which is an essential for good photographic results. Various spot-lights, mercury lights and huge search-lights are combined to secure lighting effects unheard of a few years ago. The electrical staff is consequently an important factor in production and the connected load is large when special features are being taken. Motor-generator sets are used for the

The Lasky Studio carpenter shop. The usual hazards of the woodworking industry are present here. A sprinkler system would improve conditions greatly.

heavy arc light if only alternating current supply is available. Portable generating sets consisting of a truck containing gasoline engine and direct current generator are invaluable equipment when taking scenes beyond reach of pole lines, "on location." Many types of lights are employed, the largest being 36 inch search-lights developed especially for studio work, using a current of 150 amperes. Mercury lamps of Cooper-Hewitt type are used in banks to obtain the equivalent of daylight on dark stages.

Dressing Rooms.

The dressing room section requires especial care both as to construction and inspection. The smoking hazard is greatest here and incombustible construction is of value in preventing cigarette and match fires. Automatic sprinkler protection is of great value, and when possible should always be provided. One interesting dressing room fire was caused by an electric curling iron in contact with celluloid toilet articles. One sprinkler head opened and extinguished this fire, preventing what otherwise probably would have been a serious loss.

Property Storage.

This is usually of considerable value, much of it combustible and easily damaged. Housekeeping is of great importance. Flimsy decorations or similar material should have especial care.

A set built inside a stage at the Christie Studio. The difficulty of placing sprinklers to protect such properties is evident.

Carpenter and Paint Shops.

Carpenter and paint shops constitute one of the most important fire hazards of the usual studio group. Their hazards are the same as those common to all carpenter and paint shops, and should be similarly safeguarded. Glue pots should be insulated from adjacent inflammable material. Gas stove connections should be iron pipe rather than flexible tubing. Sawdust and shavings disposal should be effective. Steam pipes and vents from heaters should be kept away from woodwork. Storage of lumber on the premises should be a minimum; a large stock may contribute sufficient fuel to render difficult the control of a fire. All bearings of machinery should be inspected and motors properly housed and protected. Oils, paints, turpentine and varnishes constitute a hazard which good housekeeping can practically eliminate. Oily rags are breeders of spontaneous combustion and should be kept in metal containers, or preferably destroyed. Paints, gasoline, benzine, and naphtha, should be kept outside of the building in an isolated structure, of fire-resistive construction.

The Laboratory.

This most important department of the studio, if not in a separate building should be entirely cut off from the stages, dressing rooms, property rooms and shops. It consists of seven departments, briefly described below in the order in which the film passes through them.

PERFORATING ROOM. Perforating is not always done in the laboratory as some studios purchase both negative and positive stock already perforated.

Perforating machines are of extremely accurate workmanship and operate with little attention. The perforation must be practically perfect, or the results will show on the screen. Since the magnification in large theatres may be 300 diameters, any inaccuracy is objectionable. Scraps of film should be in receptacles, with a minimum of exposure to a spreading fire. In the new Metro perforating room, all scraps will pass down chutes to water tanks.

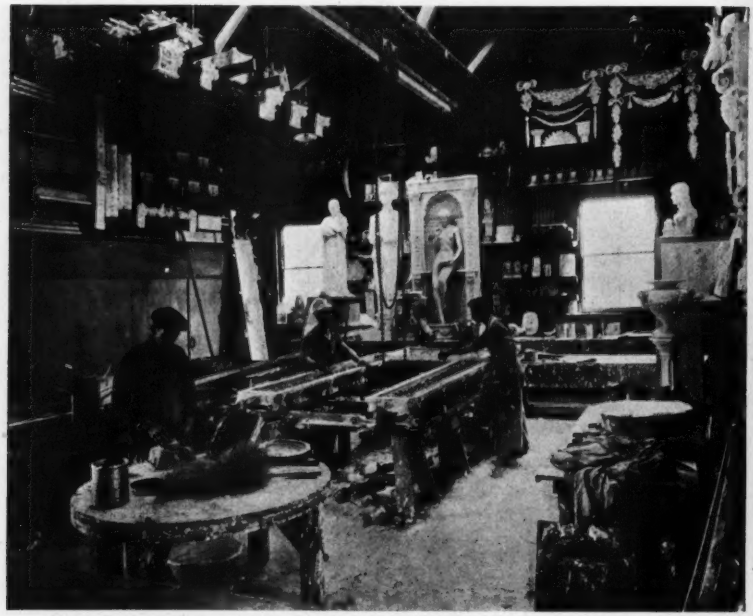
PRINTING ROOM. Printing of the positive film from the negative requires accuracy, to ensure perfect projection from the finished positive. The printing machines may employ a continuous motion of the two films, or an intermittent film motion duplicating the motion of the negative film when exposed in the camera. Since the positive film need not be as rapid as the extremely sensitive negative film, a lower speed of printing than 16 per second is common.

DEVELOPING ROOM. The developing room is designed for the minimum of labor and of time, rapid release of prints being necessary at times. The film is wound on racks and lowered into the developer. Water purifiers are found necessary for washing, distilled water being used in mixing developing solution.

DRYING ROOM. The drying room equipment consists of large wooden drums up to 12 feet in diameter, upon which the developed film is wound. Air is blown through the revolving drums, usually at a temperature of 75 degrees and a relative humidity of 60. The air must be kept free from dust, and the film dried slowly to avoid curling. Negative film should be removed promptly upon drying, to avoid twisting which makes it difficult to handle. The film is unwound from the drums into baskets and is immediately run upon re-winding machines. Heating equipment of the drying room should be at a safe distance from the drums. In some cases sections of film have been damaged because of a softening of the emulsion when drums close to heating pipes have been stopped for a time. Gas heaters, formerly used in drying rooms, have been generally supplanted by hot air or steam heat. Since the small amount of film in this room at any one time is wet, and is so distributed as to cause little or no damage from fire, automatic sprinklers are not usually installed.

POLISHING ROOM. The film is polished on the reverse side, either by hand or by machine, to remove water marks, and is wiped with cheesecloth soaked in gasoline or preferably carbon tetrachloride to clean the emulsion side.

CUTTING ROOM. The exposed negative film is examined and cut to make the finished sequence of the picture. The titles are also inserted where specified. In this room housekeeping is of the greatest importance. It is found that safety cans for film scrap are not usually practicable because of the effort required on the part of the employee to open them frequently. In some cases film scrap litters the floor, creating a very dangerous hazard. Exits from the cutting room should be ample, because of the extremely rapid spread of film fires, and the consequent danger to life. Where possible, exits should be arranged on all sides of the room.



The plaster shop at the Paramount Studio. The use of glue pots and paints here makes good housekeeping essential.

The amount of film not in containers should be as small as possible. No person carrying matches should be allowed in the room. A match, pulled by chance from a pocket of a visitor, is a menace to property and life. No matches of any kind should be permitted in the laboratory. The practise of the Eastman Kodak Company of requiring all matches to be thrown in a box when employes enter the plant, and furnishing safety matches to those who desire them when leaving the plant, is most commendable. The amount of current used on the repair desks should not exceed 15 amperes and the wiring and ventilation of the desks should have careful inspection. Metal covered desks are required by ordinance in some cities, but experience indicates the suitability of a layer of finished maple flooring surface.

Causes of Laboratory Fires.

The causes of film fires in the laboratory are varied. In one recent case a can six inches in diameter and eight inches high, without a cover, was standing in direct sunlight. Scrap film in the bottom was ignited by the focusing effect of the inside of the can. In another case, a roll of film in a container was decomposed by the heat from a large incandescent lamp close to the container. One film fire is supposed to have started from focusing of sunlight by imperfection in a window pane. A broken electric light bulb has been stated to have started a fire. Film hanging against light bulbs will ignite and exposed steam radiators are obviously to be avoided.

New York street scene built at the Paramount Studio. The type of construction is shown by the building in the right center.

None of these hazards should be allowed to exist in a well regulated laboratory. The whole question of film fires resolves itself into the one factor, housekeeping. While film is in process in the laboratory, it is usually in rolls or on reels and consequently more difficult to ignite in the absence of open flame. The quantity of loose film should be minimized while being examined. Scrap film should never be in evidence, especially on the floor, but should be in suitable containers and removed from the building at frequent intervals.

The new Metro cutting rooms are to be equipped with chutes from each cutting room to the basement. The film scrap is to pass down these chutes into water tanks. The interior finish of the cutting rooms is to be entirely of white tile. The film for each picture will be in shelves on a small truck in proper waterproof containers, which, when wheeled into the vault at night, will become a fixture of the vault, protected by automatic sprinklers. No roll of film will be allowed outside of its container, unless actually being worked upon.

The cutting room is one of the portions of the laboratory where automatic sprinklers are a positive necessity. Great damage may occur in a very short time, if open film is present to spread the fire. The value of the contents of the room may be high, and automatic sprinklers are the logical safeguard to employ. While the doors to vaults are theoretically always closed, in too many instances they are left open, in which

case, without sprinklers, there is no hope of saving the contents.

At intervals during cutting and insertion of titles, the film is projected on a screen, to eliminate sections which are not up to desired quality and ensure the perfected final assembly of the film. Experience has shown that this projecting room should be cut off from the cutting room by suitable fire-resistive doors and partitions.

No portable lights, or stationary lights which are within reach, should be permitted. The windows should be ground glass. In some cases satisfactory results in the examination of films are secured by light from the windows.

Fire Record.

Complete statistics on the fire loss in motion picture producing plants are not available. It is probably true that the industry has been extremely fortunate in its fire losses, considering the great values involved.

A fire record of motion picture fires which appeared in the January 1918 QUARTERLY attributes the great majority of fires to the handling of film. Most of the fires recorded were in motion picture theatres. Other fires have been reported in the October 1910 QUARTERLY on pages 216 and 224, in the July 1914 QUARTERLY on pages 109 and 114, and in the October 1914 QUARTERLY on page 217.

It should not be inferred, however, that fires in studios are uncommon. The writer can recall five fires which occurred in Los Angeles studios during the past year with an aggregate loss of $160,000. The fact that no plant has been subjected as yet to a sweeping fire is no reason for slighting matters of fire prevention and protection.

Conclusions.

In view of the present magnitude of motion picture producing, and its undoubted enormous development in the next few years, including the practically unexploited field of films for business, education and the home, the following may well be the aim of the executives of every producing plant and laboratory:

1—Continuous vigilance in housekeeping.

2—A well-defined program of elimination of existing fire hazards, as circumstances will permit.

Such is but sound business policy, commensurate with the progress and importance of the motion picture industry.

Sisal; An Investigation of Its Hazards.

Extracts from a Report Prepared by A. H. Nuckolls, Chemical Engineer of Underwriters' Laboratories.

(Member N. F. P. A.)

Large quantities of sisal are imported annually to the United States, principally through the port of New Orleans. Stocks of very large value are stored not only in New Orleans but in other gulf ports and in the interior, particularly Chicago and Indianapolis. It is reported that the approximate value of sisal stocks in the latter city alone has amounted to over $5,000,000. Such a large stock comprises the contents of various warehouses. About 40,000 bales is the maximum amount known to be subject to a conflagration. The fire insurance companies covering such large quantities of sisal are greatly interested in obtaining information as to the inherent fire hazard of this product, particularly its susceptibility, if any, to spontaneous ignition. The Louisiana Fire Prevention Bureau and Smyth, Sanford & Gerard of New York City arranged to have Underwriters Laboratories conduct an investigation of the subject. This work has extended over a period of two years.

Description.

Sisal or sisal hemp is the fibre obtained from the leaves of the Agave*, a native of Central America. There are several varieties of the fibre, known by their Mexican names. The product referred to in this report is known as henequen, which is principally grown in Yucatan, and is the commercial sisal of commerce in this country**. It has been highly prized and extensively used by the Mexicans for centuries. The demand for the fibre has increased very rapidly in the United States, where it is used in the manufacture of ropes, binder twine, bagging, etc., and has to a large extent replaced jute and hemp. The annual crop is comparatively large, being in the neighborhood of 900,000 bales, practically all of which is shipped to this country. The bales, while not uniform in size, are usually about 4 x 4 x 3 ft. and average about 385 lbs. in weight. The bales are bound by twisted fibres of sisal.

The fibres are white to pale straw in color, 2½ to 6 ft. in length, and have a distinctive wavy appearance. They are comparatively hard and stiff but are smooth and straight and have great strength. Next to Manila hemp sisal is said to be the strongest of the hard fibres of commerce. The fibre is readily separated from the leaves, which are transported to stripping machines where the pulp is removed and the remaining fibre is washed, no special treatment or chemical process being used. The wet green fibres are then placed in the drying fields and cured in the hot tropical sun, after which they are baled by the

*The Agave is a genus of leaved plants of the Amaryllidaceoe.

**Not to be confused with the false sisal hemp that grows wild along the coast of the Florida Peninsula (Agave decipiens).

natives using sisal ties or ropes. Steel ties have not been employed owing principally to the added expense which would be incurred, as the cost of production is an important item. There are very few rainy days in Yucatan, but in case of rain the exposed bales are covered with canvas when possible. Any wet bales are usually rejected by ships. Information from reliable sources is that this process of curing sisal has been in operation for a long time and only a few efforts, which were experimental only, have been made to artificially dry the fibre.

Investigation.

The investigation was conducted to obtain information relative to the tendency, if any, of sisal to ignite spontaneously when in transportation or storage. Tests were planned to yield data on the combustibility of sisal, its spontaneous heating, the conditions under which heating occurs and the factors influencing it.

The combustibility of sisal, including its temperature of ignition, ease of ignition, etc., was investigated in this connection to determine the heat or temperature required to produce ignition. The scope of the investigation and the features included are indicated in the following outline of the work, which indicates in the first column the main divisions; in the second, the sub-divisions or features involved, and in the third column the titles of the tests by which the corresponding data were sought.

COMBUSTIBILITY	Temperature of Ignition	Heat Ignition Tests
	Ease of Ignition	Spark Ignition Tests
	Rapidity of Burning	Flame Ignition Tests
	Effect of Heat	Heat Ignition Tests
SPONTANEOUS HEATING PROCESS	Oxidation	Spontaneous Heating Tests of Extracted Matter.
	Fermentation	
	Decomposition (rot)	Spontaneous Heating Tests with Specimens.
	Rate of Spontaneous Heating	
	Temperature Developed	Spontaneous Heating Tests with Bales
	Duration of Heating	
	Damage by Heating	
CONDITIONS UNDER WHICH SPONTANEOUS HEATING OCCURS AND FACTORS INFLUENCING IT	Moisture	Spontaneous Heating Tests with Bales
	Cure	
	External Temperature	
	Pressure	Analytical Tests
	Surrounding Gas	Temperature Measurements in Warehouses
	Damage by Water	

(Detailed descriptions of the tests made appear in the original report but are not included in this extract.)

Samples Used.

About 2100 lb. of sisal, consisting of five bales weighing 530, 435, 336, and 350 lb. respectively were employed for test purposes. Bales No. 1 and 4 were obtained from the warehouse of the Schoenoffen Brewing Co. of Chicago. Bale No. 3 was supplied by the International Harvester Co. of the same city. Bale No. 2 was obtained direct from Yucatan via Texas City, Texas. It was wrapped in paper to protect

A Burning Bale of Sisal.

it from the weather. Bale No. 5, reported to be representative of the uncured product, was obtained wrapped in burlap direct from Progreso, Mexico via New Orleans, La. On examination of this bale the fibres appeared to be identical with those of cured stocks.

Combustibility of Sisal.

Sisal whether loose or baled presents a considerable fire hazard when exposed to sparks or flame, such as red hot cinders, lighted cigarettes, flash fire from sparks and flames from matches.

IGNITION BY HEAT. The apparent ignition temperature is about 325°C. (617°F.). When the product is heated fairly rapidly to this temperature ignition results. When heated at 100°C. (212°F.) for 96 hours no charring occurs. At 130°C. (266°F.) the fibres are charred.

Prolonged heating at 266°F. or above would probably result in ignition. The results of the Heat Ignition tests indicate that while the fibres are damaged by long heating at 60°C. (140°F.) a higher temperature is required to produce ignition.

IGNITION BY SPARKS AND FLAME. The product is easily ignited by contact with ordinary sparks such as are discharged by coal burning locomotives or lighted cigarettes. Ignition readily occurs by contact with a small flame such as produced by an ignited match.

COMBUSTION. When ignited by contact with flame sisal burns rapidly, the flame spreading very fast and producing a hot fire. Local flash fires occur on ignition by a flame, but the area covered by the flash period is not large. The flash is produced by projecting ends of fibres, the number of which at any given place on the bale varies. Ignition from contact with live sparks may result in the immediate production of flame or a smoldering fire which is likely to burst into flame sooner or later according to conditions. A smoldering fire may burrow to a considerable extent.

The flaming combustion of a bale is more intense during the period when the exposed surface is burning, following which a smoldering and burrowing combustion predominates. The results of the tests indicate that a fire will progress less rapidly in a stock of bales having a minimum amount of exposed surface.

Spontaneous Heating of Sisal.

Sisal when wet heats spontaneously.

FERMENTATION AND DECOMPOSITION. The results of the tests indicate that the process of spontaneous heating of sisal is primarily one of fermentation, carbon dioxide and ethyl alcohol being among the products formed.

TEMPERATURE DEVELOPED. The tests show that a temperature of 60°C. (140°F.) may occur within the bale.

OXIDATION. The results of tests with specimens and matter extracted by acetone indicate that sisal is not easily oxidized at temperatures in the neighborhood of 60°C. (140°F.).

RATE AND DURATION OF SPONTANEOUS HEATING. The test results show that spontaneous heating develops in about 40 hours after wetting the bale, and produces a rapid rise in temperature of about 30 to 35°C. (54 to 63°F.) during the succeeding 40 to 50 hours.

Spontaneous Ignition of Sisal.

Baled sisal is not liable to spontaneous ignition under ordinary storage conditions.

The above conclusion refers to cured sisal known as henequen, which is principally grown in Mexico and is the sisal of commerce in this country. The fire hazard of any related hard fibres of this family met with commercially under the name of sisal is probably in the same class.

The susceptibility of the fibres to spontaneous heating when in a loose state unless in large piles probably would be similar to that of bales.

Test data are not available relative to the tendency, if any, of the uncured fibres to ignite spontaneously, but it is judged that their behavior in this respect would be in general similar to that of the cured fibres;

possibly the uncured product is somewhat more susceptible to spontaneous heating. Reliable information regarding the curing process indicates that the fibres are easily cured and that the possibility of bales reaching this country in the green condition is very remote.

The addition of oil to sisal increases its flammability and may render it liable to spontaneous ignition, depending upon the nature of the oil.

CONDITIONS UNDER WHICH SPONTANEOUS HEATING OCCURS AND FACTORS INFLUENCING IT. The results of the spontaneous heating tests with specimens and bales together with the temperature measurements made in warehouses show that the dry sisal containing a normal moisture content, 10 per cent by weight of water, is not subject to spontaneous heating. These tests included new and old sisal when under both laboratory test conditions and practical storage conditions.

The results of the tests with bales show that, when wet, sisal has a tendency to heat spontaneously, but the temperature developed is below that required to obtain ignition. The temperature developed by spontaneous heating in the tests with bales was determined under various conditions, including the factors of major importance which are known to influence the process of the spontaneous heating, and also factors which it was thought might have a bearing on the results. The varying test conditions and factors referred to include: the moisture content of the bales, the surrounding temperature, the pressure, the air supply and the presence of carbon dioxide, a product of fermentation.

Test variations in the moisture content included bales containing 10, 20, 30, 35 and 40 per cent by weight of water, using both rain and distilled water. The results show that maximum heating of bales occurs within this range.

The tests included surrounding temperatures of about 25°C. (77°F.) and 35°C. (95°F.). The external temperature at the surface of the bales during spontaneous heating was higher than the surrounding walls of the box. By raising the exterior temperature the loss of heat produced by spontaneous heating within the bale is reduced. The object of reducing the loss of heat was to obtain a test condition similar to a heating bale when surrounded by adjoining bales, as may occur under actual storage conditions. The results of tests using preheated air indicate that the surrounding temperature range employed was sufficiently high for the purpose sought.

Tests are included in which the air supply or ventilation of the bales was varied during the period of spontaneous heating.

The pressure to which a bale is subjected under storage conditions varies, and a test was included to obtain data on the effect, if any, of increasing the pressure on the bale during its period of spontaneous heating. As the result of this test indicated that the pressure employed did not appreciably accelerate the heating of the sisal or augment the temperature, no additional pressure tests were deemed necessary.

A test in which the carbon dioxide, resulting from the fermentation of the sisal, was removed is included, but no evidence was obtained that the temperature rise from spontaneous heating was appreciably affected by this procedure.

Prolonged decomposition tests, extending over a period of years, are not included

Examination of the fibres following the spontaneous heating tests, and additional heating yielded no data indicative of any tendency of the sisal to undergo active oxidation and ignite spontaneously.

DAMAGE BY WATER. It appears that practically no expansion occurs on wetting the bales. It is impracticable to dry the product.

STORAGE CONDITIONS. It appears from a study of the test data that in the storage of sisal precautions should be taken to:

(1) Exclude any of the product which is wet.

(2) Store in warehouse protected from the weather and exposure to sparks and flame.

(3) Preferably exclude other products.

(4) Avoid exposing a larger bale surface to the air than is consistent with safe practice in allowing aisle space for work of extinguishing fire and removing bales. Numerous sub-divisions of storage space by partitions is preferable.

Progress in Hose Coupling Standardization.

By F. M. Griswold.

(Member N. F. P. A.)

The following brief report of a fire which occurred recently tells an old and familiar story.

Lack of standardized hose couplings made it impossible for Eldora, Iowa, to receive aid from several fire departments which responded to calls for help when a fire occurred in that town, resulting in a loss of $150,000. Departments came to Eldora from Iowa Falls, Grundy Center, Hubbard, Ackley and the state training school. It was impossible to use the hose of the Iowa Falls Fire Department because of the difference in the size of threads in the hose connection. The visiting departments could only assist in preventing spread of the flames. It is said that if the Iowa Falls Department could have used its truck and hose connection, fire in the tower of the court house could have been extinguished almost as soon as it was discovered. As it was the fire had to be fought from the roof of the court house and then ineffectively. Rain made it possible to prevent greater damage.

While it is true that reports of this nature are not now as frequent as formerly, they are still in sufficient number to make the matter of standardization of hose couplings of great concern for the safety of cities and towns against conflagrations. Activity in this connection has been spread over so many years and covers so broad a field that a survey of what has been accomplished and what is now being brought about will doubtless prove of decided interest to those interested in the success of this highly important undertaking.

As N. F. P. A. members may recall, the original committee of four members, selected by the Association in 1905 to attempt co-operative action in securing the standardization of public fire hose couplings through-

out this country, began its active operations at a meeting of the American Waterworks Association at West Baden, Ind., and laid the foundation for future effort by securing from that Association its acceptance and approval of the specifications submitted for creating such a standard as would be most inclusive in its possibilities. From this initial success the committee labored ceaselessly to push the work to completion as rapidly as possible, with the result that at the opening of the year 1917 the scope of its work had become so extended and demanded such close and skilled attention that a volunteer committee could no longer devote the time and attention its importance warranted. Its work was therefore transferred to the National Board of Fire Underwriters, whose corps of skilled engineers took up the work and have since done much to bring the matter to a position where its future success seems to be insured.

At the 1918 convention of the N. F. P. A., a report was submitted showing progress in the work, and indicating the early completion of a set of tools and devices through the use of which conversion of non-standard to interchange with standard couplings seemed to solve the problem in a very satisfactory manner. This conclusion was fully supported by the excellent results obtained in field-work during May and July of 1919, when the first sets of completed tools were used in the conversion of couplings in several towns in New Jersey, Pennsylvania and Indiana, at the request of the public authorities.

The success of this work served to awaken wide interest among waterworks organizations, inspection bureaus and fire marshals. This resulted in the purchase of several sets of these tools by various organizations in a number of states. The Greenfield Tap and Die Corporation reports that fourteen complete sets of standardization tools have been shipped and several more are in order. One or more of these have gone to the States of Michigan, New Jersey, Indiana, Ohio, Kentucky, Iowa and Minnesota.

Progress of Work During 1920-1921.

In the State of Michigan the work was carried on under the direction of the Michigan Inspection Bureau. With two sets of tools furnished by the Bureau, standardization has been completed, or is in process, in thirty-five towns, of which the largest are Flint, with a population of 90,000, and Lansing, with a population of 55,000. To May 1, 1921, there had been a total of 13,000 fittings recut, which include 3,560 hose couplings and 9,277 hydrant fittings. The work was suspended during the winter but was started again and prosecuted with vigor, using the two sets of tools during the summer and as long as weather permitted in the fall. It is estimated that with the experience so far had, the State of Michigan can be standardized within the next three years.

In this connection, the following tabulated statement, naming the towns where conversion has been completed, and indicating the nature of the operations carried out, is of particular interest in relation to the number of men employed, and the hours of labor expended in the completion of the job in each locality, as it well illustrates both the feasibility and practically negligible expense incident to the ready conversion of these utilities:

Town	Population	No. Men	Hours	Hose Couplings	Hydrants	Other	Total
Constantine	1500	3	9	42		5	47
Sturgis	6000	4	24	68		4	72
Three Rivers	8000	3	53	378	196	6	580
Vicksburg	2000	3	25	122	144	35	301
Marcellus	1200	3	10	46	80	9	135
Schoolcraft	800	3	8	40	68	4	112
Mendon	1000	4	6	72	36	2	110
Dowagiac	5500	4	36	308	275	60	643
Decatur	1500	2	24	52	80	6	138
Cassopolis	1550	2	28		100	5	105
Paw Paw	1800	2	20	32	80	20	132
Lawton	1100	3	4	42		5	47
Berrien Springs	1200	3	3	68		4	72
Niles	7100	3	41	157	426	10	593
Three Oaks	1300	3	20	70	163	25	268
New Buffalo	600	3	5	46	12	6	64
Benton Harbor	12700			256	1256	72	1584
Watervliet	1200	2	40	108	218	26	352
Mt. Clemens	9500			196	1036	14	1246
Marysville	2000			120	176	6	302
Lansing	55000			290	1720	36	2046
St. Clair	3200			120	252	16	388
South Haven	5000			54		8	62
East Lansing	800			15	54	3	72
Armada	750			60	108	2	170
Richmond	1300			68		2	70
New Baltimore	4000			40	132	5	177
Charlotte	5000	3	80	138	269	12	419
*Flint	90000			464	2200	45	2708
*Eaton Rapids	2100			88	196	6	290

* Work not completed.

(Where data as to number of men and hours are omitted, information is not obtainable, or records not yet complete.)

In New Jersey the Schedule Rating Office furnished two sets of tools and arranged for their use. The work so far done has been in the territory supplied by the Hackensack Water Company, which has undertaken to use the tools in forty-six cities and towns supplied with water by that Company. Practically all of the towns have made application to have the hose couplings standardized, and up to May 1 the work in sixteen towns has been completed. The East Jersey Water Company has agreed to standardize the couplings in all of the towns served by it, except that in Patterson and Passaic the fire departments will treat the hose couplings. Other water companies have agreed to handle the work in the territory served by them and the State Fire Chiefs' Association has undertaken to co-operate actively in furthering the campaign and in securing the support of municipal officials. A large number of towns are listed for attention as soon as the tools are available.

This record of progress in the State of New Jersey evidences very practical co-operation on the part of waterworks organizations, marking as it does, a proper appreciation of an implied, if not a strictly legal obligation, to better safeguard the interests of the public whom they serve, thus setting an example of wise public spirit, worthy of emulation by all organizations of like character, whether they be private or municipal as to ownership.

The Indiana Inspection Bureau standardized couplings in eleven cities and towns, of which the largest is South Bend, which has a population of 75,000. A total of 2,345 hydrants and 1,331 lengths of hose have been treated. The work is arranged for six other towns and the prospects for continued progress are excellent.

State Fire Marshal Nettleton of the State of Minnesota reports that

couplings have been standardized in three cities in that state and one in North Dakota. The work was suspended for a time on account of the cold weather last winter, but was resumed again with thirteen towns ready to have their couplings standardized. During the summer the work in thirty-five or forty towns was completed.

Other states have purchased or ordered tools, and are planning to start active work very soon.

It is also very encouraging, as well as an important fact, to be advised that the National Screw-Thread Commission, appointed by Congressional action to formulate standards for all classes of screw-thread devices, and working under the supervision of the U. S. Bureau of Standards, has accepted and adopted the N. F. P. A. Specifications as its standard for fire department service.

On written application from the proper public authorities to the Inspection Bureau having jurisdiction, or to the state fire marshal having such tools at his command, a full set will be gladly loaned for the purpose of conversion, practically without expense to the community applying, and in either case, men properly skilled in their operation will be sent to supervise the work, if requested; it is therefore evident that no valid excuse will now serve for doubt or delay in this important matter of conversion, the practical and easy accomplishment of which has been demonstrated beyond question.

No intelligent man will dispute the wisdom and necessity for bringing all public fire-fighting utilities into such conformity as will best insure successful resistance to the spread of flame, the safety to life and the conservation of vested property values in case of disastrous conflagrations, now so common in this country. The proper solution of this important problem is the prompt conversion of all non-standard equipments to interchange with the accepted National Standard by the utilization of the means now at the command of all.

This is a "phony" picture—the cigar smoke is "retouched," but it is typical of the carelessness responsible for an average annual loss from "smoking and matches" of nearly $15,000,000.

Brick Walls for Residences.

A Discussion of Proposed Relaxation of Requirements.

By Charles E. Worthington
(Member N. F. P. A.)

The appointment by Secretary Hoover of the Department of Commerce of the excellent committee to consider the standardization of Building Codes serves among other things to bring into prominence the plea of the Common Brick Manufacturers Association for a modification of accepted brick wall construction, especially the requirement of twelve inch walls in certain cases.

This plea, brought forward by Architect William Carver in a carefully prepared and well illustrated booklet, is presented in a temperate and thoughtful manner; it represents at least their point of view fully and appears in the main to have anticipated and answered much possible criticism. This book although covering more fully the subject of the small folder recently mailed to members of the N. F. P. A. is a paper bound volume* too bulky and expensive to be distributed indiscriminately. It contains much valuable tabulated information and records of tests not previously brought together, although it is advertising matter in the sense that its design is the promotion of the brick making and building industries.

The advocacy of what the author terms the "Ideal Rolok Wall" is one of the main purposes. This method of construction consists in general of laying the brick on edge, breaking joints and laying each alternate brick through the wall, the surface of which thus presents the flat sides and ends successively in each course; this is an 8-inch wall providing a central air space.

This method of construction is not a novelty in some parts of Europe and is not unpleasing in appearance, but the determination of its merit is not the purpose of this discussion.

It is notable in this case that unlike the majority of such pleas, concession for special construction is asked only for a specific class of buildings. Questions of this nature have usually been settled by obtaining the concensus of opinion of a considerable number of persons reputed to be qualified to speak by reason of occupation, education or special experience (a sort of limited referendum), and the adoption of substantially the method favored by the majority, especially if the majority appears to be a decisive one. This method in this case is apparently impracticable from the fact that it is the prevailing concensus of opinion that is put on trial, and an accused cannot well be constituted judge and jury to try his own case.

Concensus here means in the main the voicing of fixed opinions, largely acquired from custom or inheritance, but difficult to change; opin-

* "Brick, How to Build and Estimate," Common Brick Manufacturers Association of America, Schofield Building, Cleveland, Ohio.

ions not always to be influenced by evidence and not always dependent upon other than superficial views. In such a case even an overwhelming majority may render a verdict not in accordance with fundamental facts and it might be far safer to call for thorough scientific tests and experiments, disregarding preconceived opinions, and relegate the decision mainly, if not entirely, to such competent and disinterested bodies as the United States Bureau of Standards and the Underwriters' Laboratories.

This determination affects not merely the brick makers but is vital in the matter of the housing shortage; one of our most pressing economic problems. The housing shortage must, however, be taken as a shortage of homes, a condition calling for the promptest practicable relief for individual home builders but not applicable to speculative or commercial building construction.

The plea of the Brick Manufacturers Association as expressed by Mr. Carver is only for the sanction of eight inch exterior walls of hollow construction ("Ideal Rolok Construction") for small residences wherever located, not for buildings designed for mercantile uses or for apartment houses. And since the maximum height of side walls for a moderate sized residence or two family tenement will never exceed twenty feet (nor the average of the gable walls twenty-five feet), and the length of such walls may be restricted to a maximum of about fifty feet without in the least impairing the purpose in view, there may be some features of this plea worthy of very careful if not favorable consideration.

Our building codes in general appear to base wall thickness upon permissible floor load and fire hazard, stopping, however, at a floor load suitable for light mercantile use of 125 pounds per square foot, making no concessions for lighter loads, and drawing no distinction between the necessary thickness of fire walls and exterior walls not in contact with others.

It is notable as a factor in this discussion that Mr. Carver's book insists upon a twelve inch minimum for fire walls and party walls and upon solid brick construction for such, realizing the necessity of at least four inches of brick between the ends of joists or timbers. The need of this restriction should be evident although it does not seem to be considered at all in some codes where eight inch walls are permitted, no distinction being drawn between exterior walls and others. This should be stated here in justice to the proponents.

But, in event of fire the thrust which collapses a wall is not only determined by expansion, (height and length) but by the floor load within, and all other conditions being equal a wall may collapse under a load of 125 pounds that would safely pass the ordeal with fifty pounds. Hence while we will universally concede the twelve inch minimum for party or fire walls, it is by no means certain that this requirement should be uniform for loads under and above 125 pounds. That which is quite adequate for a residence of 2½ stories (20 feet high) may not suffice for a tenement wall of 3 stories or 30 feet.

Moreover sanitation requires isolation of residences to some extent for light and air. Where such are necessarily built in rows there is ample spacing front and rear, a condition not applying at all to mercantile construction and enforceable only to a limited degree in case of tenements (sometimes called apartment houses for euphony or to escape

sanitary restrictions otherwise imposed).

This spacing is important from an economic point of view, for in the so-called "congested districts" the cost of the land makes it imperative that the structure shall cover practically the entire area in order that financial return shall be adequate.

As an extreme example, suppose when the Equitable Building on Broadway, New York, burned, the State of New York had passed an act abrogating fire limit restrictions on this property and authorized the erection of wooden dwellings on the site, restricting, however, the size to 1500 sq. ft. of area, height to 2½ stories and providing a minimum spacing of 10 ft. on both sides to lot lines, 40 ft. in rear and a 50 ft. "set back." Does anyone dream that advantage of this permission would or could have been taken and buildings of very limited rental value erected upon land whose cost not only compels the utilization of every inch of area but demands vertical expansion of twenty or more stories in order to get rental spaces sufficient to return any interest on the investment?

This "congested district" argument is sometimes put forward by commercial or speculative interests with the object of increasing the permitted height limit to above 20 feet, and length to more than 50 feet; increases that would let in mercantile construction with its more than double floor loads, large areas and much greater volume of combustible material. As a matter of fact no one is at all likely to *desire* to build a residence in a congested mercantile district and if there should be such a person at occasional intervals financial considerations would restrain him.

Present building conditions, reached by years of effort, cannot yet be called ideal. We have yet too much light brick construction, particularly in hotels and tenements ("apartment houses") of all classes, the permitted construction of "apartment houses" in particular having long been a common target for criticism. There appears to be, with the sole exception of small residences, no economic or other conditions that even remotely suggest "downward revision" of building requirements in any particular, although "upward revision" is desirable in many cases and particulars; and it may be added that no other class of buildings than residences of small height and area can be at present provided for by practicable legislation so as automatically to regulate the matter of fire protection.

Before taking up the reverse of the shield a little consideration of the housing shortage may be desirable.

There are in the United States about 23,000,000 families out of which about 4,000,000 report to the income tax collectors. Eighty-nine per cent. of this 4,000,000 report taxable income of $3,000 or less, which including exemptions is a stated income of approximately $5,000.

The 11% with incomes in excess of $5,000 can take care of themselves. The others feel the pinch in varying degree, but in the main these are able to build when and where they choose without very great regard to small economies. But, with the 19,000,000 families whose income is $2,000 or less the case is different and public policy requires that their needs be carefully considered.

Governments and other economic authorities recognize the evils of

too great a floating population and concede the principle that the citizen bound to the soil and his locality by ties of ownership and direct responsibility is on the whole the most desirable citizen, therefore, public policy requires all possible encouragement of individual holdings in homes and farms and as far as possible discouragement of landlords in so far as it concerns these. This does *not* extend to commercial construction which is on a totally different basis.

The generally accepted rule is that a family may pay for "rent" (which means not alone rent paid to a landlord but the cost of upkeep of owned property in interest, taxes and repairs) not over 25% of the annual income, which on the average of the 19,000,000 families has been estimated at various amounts generally from $1200 to $1400. This "rent" or capitalization in a house occupied by the owner may usually be set at 10% of cost, the landlord, however, having some special expenses in the way of cost of oversight, larger repairs and a necessary provision for periods of vacancy, etc., must exact at least one-half more or 15% (in general the owners of houses built for rental will protest 15% as inadequate). These are of course not accurate figures but accurate enough to serve the purpose.

On this basis one-fourth of $1200 is $300 which accepted as a 10% "rental" means that the average home of the 19,000,000 families will cost $3,000, a cost at present prices involving very strict economy in construction and reacting upon the quality. But it is either this or pay a landlord $450 or more for equal or inferior accommodations, at the same time relinquishing the family privacy and the duties of ownership that make for good citizenship and better morale.

Possibly we are not concerned directly with morale, yet that does react in increased losses, and all people interested in fire prevention (and reduction of the heavy cost of fire protection) are interested in any measure tending toward a safer class of buildings. In general this would be the result of the substitution of brick for wood in all houses not well isolated from others. It is a problem similar to that of the wooden shingle roof, although of not so much importance.

Therefore, if we can without sacrifice of any real element of general protection encourage the greater use of incombustible materials by regulations tending to reduce building cost, the establishment of such regulations and their uniform application is a duty.

All questions of fire resistance must be determined by actual impartial test, not by mere unsupported opinions, for not only in this case are we to test the value of materials but also the value of all preconceived opinions, adverse or otherwise. In every step of our prior struggles for betterments such opinions (honest or otherwise) have been the barriers to progress. We need to get away from the rather pleasantly diversified region of "thinks" into the more restricted and monotonous territory of "know." Also we should not be content to let "well enough alone," if for no other reason than that we do not know it is "well enough" or that it may not be bettered. Beliefs or preconceived or established opinions are not always to be relied upon; the most extensive graveyard in the world is that in which discredited beliefs, many of them widely prevalent in their day, are buried.

If we are testing hollow brick walls of eight inch thickness, why

not walls of all other clay products? We should know the strength of such walls and the effect of varying loads, for a wall strong enough under ordinary conditions to carry the 50 lb. dwelling load may be entirely inadequate for the 125 lb. load assigned to "light mercantile."

Despite Mr. Carver's statement that brick sizes are well standardized such is not entirely the case, except for face brick which so far as sizes go are practically uniform in the United States and Canada and may probably without exception be regarded as possessing adequate crushing strength. It is not face brick that may be used for $3,000 dwellings, but common brick, even the cheaper soft burned grades, and the sizes of common brick offered, at least in the eastern territory, range from what is known as "New York brick" measuring 7½ x 2 x 3½ in. to brick running 8¼ x 2½ x 3¾ in., the latter exceeding the former in volume by about 50%, which would seem a larger variation than "standardization" would permit.

It must be understood that the term "eight inch wall" is commonly applied to walls the length of one brick in thickness. It is not an exact term. Similar nomenclature was formerly used in the case of fire doors, where doors 1¾ in. thick were almost uniformly designated two inch doors, despite the fact that such doors could not be constructed from dressed lumber of commercial size.

A "Rolok Ideal Wall" if constructed of face brick, or what we have called for convenience standard size, contains per unit of three brick 45 cubic inches of brick and 28 of air, if of the New York brick size 37.5 of brick and 26.25 of air, which is to say that each superficial square foot of wall, the length of one brick in thickness (disregarding any allowance for mortar) will contain, of New York brick 636 cubic inches of brick and 442.8 of air space, if standard size 710.4 brick and 441.6 air. Aside from the uncertainty involved in the use of the loose wording it will be seen that a "New York" brick wall 50 ft. long and 20 ft. high of this dimension will contain 74,200 cubic inches of brick less than one of standard brick, the deficiency being equal to about 1000 "standard" brick.

Taking the same tables the crushing strength (or rather resistance) of brick on edge varies from 119 tons to 1926 tons, which would suggest that for all weights under consideration this factor need not be considered.

There are no tables as regards absorption of moisture and increase of weight thereby, but we do not suggest that the weight increase would form a hazard, although doubtless the generation of steam in the interior of the more absorbent bricks under exposure to heat might affect stability materially. This is an important factor when the matter of direct plastering is concerned, for the evidence that transmission of dampness is entirely through the mortar is unconvincing.

All of these differences affect wall stability: volume of solid brick, moisture absorption and dimensions, not so much in solid walls where the factor of safety is very large but possibly in hollow walls where that factor is reduced and floor weights and the thrust from them are to be considered. These matters may not be considered at length but are quoted more for the purpose of emphasizing the need of incorporating some provision at least for standardizing brick sizes in any specifications in ordinances, and also that they should be considered in tests.

Plaster on wood furring and lath is simply an air space partly lined with moisture *absorbing* (not transmitting) material and enclosed in a sheathing usually more freely permeable to air than brick.

This permeability applies to ordinary brown mortar applied direct, but if transmission of moisture is considerable this will lose its adhesive qualities. Certain "hard plasters" are understood to be free from this objection, but probably as a rule hard plaster or "three coat" work would prove more costly than lath and plaster on furring. The extent to which fire hazard is increased by the ordinary furring and lath is a subject of divergent opinion. It would seem (theoretically at least) that hollow walls would avoid the moisture trouble in the main.

This discussion has been confined to brick, but in general the same principles apply to hollow tile, interlocking tile and the many other applications of clay products. They vary so much between themselves that space forbids specific consideration.

Some of these are cast with heavy webs and small air spaces, others with thinner walls are *alleged* to show a disposition to crack, or even pulverize, if water is applied while heated. It is not improbable that many of these are fair equivalents of hollow brick construction and can be safely used under restriction, a matter that must be determined by test for individual types of construction. No one at this time can presume to decide this positively.

The committee nationally appointed to consider the standardization of building codes is able to handle these questions better than any individual or ordinary group, and it is certainly not with the intent of instructing that committee that this has been written.

That with the proper spacing, sides, front and rear necessary for sanitation it is not possible to create a "congested district" out of private residences with non-combustible walls and roofs hardly needs assertion or demonstration; nor does the present economic need of favoring such construction.

But to concede any relaxation of the standards applying to mercantile construction, however plausible the plea may be, is to let down the bars to future "congested districts" of less substantial construction than are generally provided by existing laws, which existing laws are generally regarded as inadequate. Tenements, apartments and the like are commercial undertakings and in general are not a permanent factor to be considered in connection with the housing shortage. To favor their construction is indirectly to favor increase of floating population, of itself undesirable. That these are necessary and indispensible must of course be conceded but that does not change their status as commercial construction.

It is so easy to raise such questions as to the construction of dwellings in already congested districts as a means of befogging discussion that it will certainly be resorted to very largely. Nevertheless it is entirely safe to assert that with proper sanitary spacing this matter can be left entirely to natural law and the practical impossibility from a financial standpoint of such construction where it could be considered objectionable.

We have had a good many years of experience with "fire limits," as usually defined, waiting until a certain district is almost completely

built over with combustible construction and then drawing an imaginary line about that congested area prohibiting more wooden construction within that area, but permitting the growth of a ring of congestion about it. This has usually worked to the very great advantage of certain real estate interests in such particular localities but has not been conducive to present or future safety or to permanent public interest. Maybe it was the best that could be done under the circumstances, who can say? but *then* is never *now*.

Tank Car Hazards.

As the use of petroleum and its products increases from year to year, the amount of inflammable liquids transported in tank cars is reaching large proportions. Transportation of the lighter petroleum products, especially gasoline, in tank cars, involves widespread hazards which must be safeguarded.

The danger incident to transportation of gasoline in tank cars was very forcibly illustrated by the explosion of the mixture of air and escaping vapor from the dome of a car of casinghead gasoline at Memphis, January 24, 1921, with a loss of thirteen lives, eighteen injuries, and a property damage estimated at $200,000. (Copies of an illustrated report on this explosion were sent to N. F. P. A. members requesting it.)

The Bureau of Explosives (Member N. F. P. A.), which has jurisdiction in matters pertaining to the rail transportation of all dangerous articles, is actively concerned with this tank car hazard. Quoting from the last annual report of this bureau for the year ending December 31, 1920:

> The lighter petroleum products continue to maintain their place at the head of the list of all commodities transported by rail as the most dangerous from fire hazard. Out of 137,000 tank cars reported in traffic about 100,000 are used for the petroleum products alone.

In the period 1910-1920, (not including the Memphis explosion of 1921) there are reported a total of 831 accidents and fires in the transportation of gasoline, involving a loss of 98 lives, 696 personal injuries, and a property loss of $3,573,886. In the tabulation of accidents occurring in transportation of articles named in the freight lists as "Dangerous Articles," gasoline is responsible for the loss of 98 out of a total of 119 lives, and more than half of the totals of injuries and property damage. The Bureau reports that in 1920 there was an improvement over previous years due to better co-operation on the part of shippers and greater care and judgment on the part of railroad employees in inspecting and handling loaded cars. It is evident that this improvement cannot continue in the 1921 report, if the Memphis explosion alone be considered.

The principle cause of tank car fires is derailment involving rupture and leakage, followed by ignition from wreckage, sparks of grinding metal, smoking or open lights or fires. The three weak points of tank

car design, defects which are frequently responsible for leakage of liquid and vapor, a condition favorable to tank car fires, are the bottom outlet valve, the dome closure, and the safety valve. The bottom outlet valve is the worst offender, and although experiments with methods of bettering its safety are now under way no entirely satisfactory design has yet been developed, and it is possible that it may be necessary to prohibit bottom outlet valves and compel unloading from the top, although this might work a certain hardship to consignees.

Static Electricity and Stray Currents.

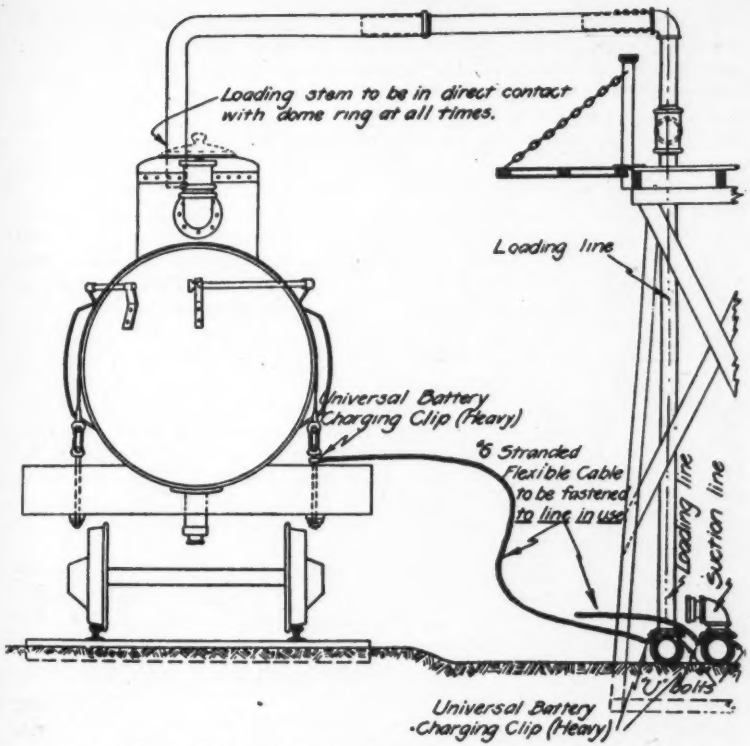
Static sparks, and sparks caused by stray currents are fire causes to which in the past little attention has been given, although they have caused a number of tank car fires. Ignition of gasoline by static electricity is so well recognized that it need not be elaborated here, but stray current sparks as a fire cause have received little consideration, and the two following fires reported by the Bureau of Explosives will be of interest in this connection.

On Dec. 30, 1919, at Gainesville, Ga., a tank car of gasoline was being unloaded on a spur track of the Southern Ry. This track had a direct connection with the trolley line of the Georgia Ry. & Power Company. The overhead trolley wire of the trolley company ended 150 ft. from where the car stood, but the spur track was not insulated from the live trolley track. A freight trolley car was being used to move a car of coal nearby and two men from the switching crew went to the tank car to remove the unloading pipe from the dome. Just as this was being done, the trolley pole was placed on the trolley wire which charged the rails of the spur track and the tank car with the return circuit. The unloading pipe in the hands of one of the men was bumped against the side of the dome causing a spark and ignition of vapor. The man escaped injury by jumping away, but the fire burned from the dome an hour and a half, and caused the loss of $500 before being extinguished by the fire department.

On July 31, 1920, at Cumberland, Md., on the Cumberland and Pennsylvania R. R., leakage from the outlet valve of a tank car of gasoline accompanied the operation of attaching the unloading connection. Ignition of the vapor from the leaking gasoline occurred from a spark when the two sections of the unloading connection were brought together. Investigation developed that the consignee's pipe line was charged with electricity through the damp soil from a trolley car system about 200 feet distant. A test following the accident showed that there was a stray current of 25 volts.

This danger may be guarded against by two methods. One is the insulating of spur tracks from main tracks carrying electric currents. Such insulation would have to be used in connection with most sidings for loading or unloading gasoline, for most railroads today operate automatic block signal systems actuated by electric currents passing through the rails and many roads are electrified for the use of electric locomotives. Some roads have both. The automatic signal system operates on a low tension current and the electromotive current is high tension. Either is capable of furnishing sufficient spark to ignite inflammable vapor under conditions favorable to such ignition. In congested districts there is also the possibility of stray currents from nearby trolley systems, electric lighting and power circuits.

The other method of protection is suitable grounding and interconnection, permanent or temporary, of rails, cars and oil handling pipes and equipment. That this is receiving attention is shown by the accom-


Loading stem to be in direct contact with dome ring at all times.
Loading line
Universal Battery Charging Clip (Heavy)
6 Stranded Flexible Cable to be fastened to line in use
Loading line
Suction line
U bolts
Universal Battery Charging Clip (Heavy)

Bonding device used by the Standard Oil Co. of California.

panying illustration of a tank car bonding device which is the standard practice of the Standard Oil Co. of California. This consists of a No. 6 stranded flexible cable attached at the ends by heavy Universal battery charging clips to both the tank car and the grounded line of the oil company. Such an arrangement will prevent any electrical sparks from operations in loading or unloading. This arrangement with the requirement of a positive metallic contact of loading pipe with the dome also furnishes protection against sparks of static electricity.

It is evident that definite rules or regulations should be promulgated by the railroads to control this hazard. The subject is now receiving attention from several sources, especially the N. F. P. A. Committee on Inflammable Liquids. Chairman Barrier plans to take up these tank car hazards at an early meeting of the committee, and to cover them in due time in a report to the Association.

The following, quoted from a letter of the Bureau of Explosives, referring this whole subject to the N. F. P. A., gives a clear summary of the problem and suggests the remedies:

"In developing suitable rules, the principal requirement should be that protection must be provided while the loading or unloading operation is carried on. The temporary plan calls for definite action by the oil company before and after a tank car is handled. The permanent plan requires no further action than inspection service after the installation is once made. With the temporary plan any leakage of current into the rails would be conducted to the piping system of the industry only while tank cars are being handled. The permanent plan, will result in any current from the track being circulated through the oil pipes at all times. Should such a condition cause electrolysis, the effect on the pipes would be more detrimental than the intermittent action resulting from the temporary plan. There might also be transmitted a stray current from the pipes to the track when no tank car is being handled. These points are mentioned for consideration in their bearing on the question of which plan should be adopted. The following rules are submitted as offering a choice of either plan:

"1. On all side track installations where tank car shipments of gasoline or similar products are to be handled, and where there is danger from stray electric currents, an electrical connection must be made between the car or track and loading or unloading pipes before the loading or unloading operation is begun. This may be provided for temporarily by a portable conductor attached to a metal tank band of the car or permanently by a protected cable or strong wire securely attached to the nearest rail on which the car stands.

"2. All oil siding rails must be insulated from other tracks when such sidings have a direct connection to tracks equipped with electrical signal system or are used by electric locomotives.

"3. Such bonding connections must be frequently inspected to insure that they are in serviceable condition."

Building Construction Hazards.

By Charles C. Dominge

(Member N. F. P. A.)

Buildings in course of construction are usually considered good fire risks, especially if of brick or fire resistive construction. Theatres, churches, halls and other types of buildings calling for a large open floor space are not as desirable course of construction risks as those of ordinary type, owing to the great amount of scaffolding necessary to complete and finish the high interior of the building.

Up to several years ago, most fires in this class have been caused by the use of "salamanders" or open fire stoves or gasoline torches as used by careless mechanics. Electricity, generally of a temporary and makeshift nature, with its exposed wires, is responsible in some cases, as is evidenced by the severe loss several years ago in the Pennsylvania Hotel in New York City. In this case a temporary overhead wood platform was erected on the grade so that pedestrians could traverse the street. Under this platform the temporary electrical installation and switchboard were installed. A fire, apparently from defective installation, started at this point and was severe enough to destroy over 150 feet of the limestone front of the building under the platform and severely scorched buildings on the opposite side of the street. Several months ago, the fire department responded to three fires in two weeks in a building in course of construction on Maiden Lane, New York City, the cause being either red hot rivets or red hot particles from acetylene welding apparatus dropping on canvas covered platforms or oil soaked litter on the floors. In these new buildings asphaltum paint is used to coat the interior walls to keep them waterproof. The usual method is to build a wood fire directly on the fireproof arches of the floor and then place a bucket filled with asphalt on the fire in order to keep the asphalt from becoming too thick, thereby making it easier to apply to the walls. A fire of this kind must be constantly watched, otherwise the liquid will boil over and start a fire which is hard to extinguish. During the winter months, buildings in course of construction house practically all the combustible materials to be used eventually in the interior finishing, and at this time there is a considerable amount of packing cases containing glass with excelsior, straw and hay packed between. The writer has seen workmen removing the glass from the cases and scattering the packing material over a great portion of the floor. Smoking and filling kerosene lanterns are also hazards met with.

In conclusion many losses occur at the eleventh hour, when the building is almost ready to be turned over to the owner. At this stage, carelessness on the part of painters and decorators in the handling and storage of their supplies, and oily rags and waste help to increase the loss ratio.

Paris Department Store Fire.

Report by Henri de Léséleuc*
Paris (Member N. F. P. A.)

The new Magasin du Printemps, a large Paris department store, was destroyed by fire on September 28, 1921, with a loss estimated at 40,000,000 francs. Fortunately there was no loss of life, as the fire started about 7:30 A. M., when there were very few people in the store. This large building, covering an entire city block, had just been completed and was to be opened in a few days.

The details of this fire show the marked differences between French and American practices in building construction and fire protection. The conditions described in this report will contrast sharply with those commonly observed in America, and on this account it is hoped that they may be of interest to American readers. France has much smaller annual fire losses than the United States and Canada. Fires are much less frequent, for several reasons, which have often been discussed by American writers. This fire demonstrates that because of the relative infrequency of fire, the science and practice of fire protection in France have not kept pace with development in America, where a fire in a store similar to the Magasin du Printemps under ordinary conditions would have been extinguished with a relatively small loss.

Construction.

The New Magasin du Printemps, on Boulevard Haussmann across rue Caumartin from the old Magasin du Printemps, covers an entire block. The building, limited in height as are all buildings in Paris, was five stories and basement. It was of so called fireproof construction, with steel frame, stone walls faced with imitation mosaic work, and floors of fireproof construction with wooden upper surfaces. The roof was of tile on wood, with steel frame. The roof was in part glass domed, the glass used being of a kind designed to resist fire.

There was a large amount of unprotected structural steel in the building, there were no fire walls or other fire stops, and there were a large number of unprotected openings through the floors, including a large ornamental open stair well. The stairs and elevator shafts had iron frames, unprotected.

Fire protection consisted of hand extinguishers and hose, both liberally distributed.

The Story of the Fire.

The fire started at about 7:30 A. M. in the furniture department on the fourth floor. The cause is unknown, although reported by the newspapers as electric short circuit. There were a few of the night staff in

*This report is a translation and arrangement of material furnished by M. de Léséleuc.—Ed.

The new Magasin du Printemps (right) seriously exposed the old Magasin du Printemps (left) when it was destroyed by fire on Sept. 28, 1921. (See also Frontispiece.)

the building at the time, watchmen and cleaners. The force of watchmen includes thirty ex-firemen, but comparatively little use seems to have been made of the fire appliances in the building.

An alarm was given at about 7:40 A. M. The nearest fire station was about a mile away, but it was some twenty minutes before the arrival of the first engine, and the best part of an hour before four engines had arrived on the scene. The fire spread rapidly laterally, and up and down through the elevator shafts. The efforts of the store personnel were concentrated on saving stock, but this work soon had to be abandoned.

The fire brigade was greatly hampered by lack of water, a fireman on a ladder at the height of the fourth floor having to wait no less than seventeen minutes for water to come out of his hose. Bursting hose also gave much trouble. The fire continued to spread in the building; between 10 A. M. and 10:30 A. M. the entire interior was involved and parts of the glass roof had collapsed. By this time additional apparatus had arrived and thirty hose streams were being used. The efforts of the firemen were concentrated on preventing spread of the fire, especially to save the old Magasin du Printemps across the narrow rue Caumartin. A number of hose streams were used here, and spread of the fire was prevented. A subway connecting the new and old stores was cut off by an iron door backed up by bags of earth hurriedly placed during the fire.

By noon the crowd was dense, and would have hampered the work of the firemen had it not been for the large force of police, the entire force of the central district of Paris being assigned to duty at the fire. One amusing incident reported is that at one time the crowd mistook

View of the Magasin du Printemps fire from Boulevard Housmann, looking down the rue Caumartin. Motor apparatus in foreground. It was almost an hour after the alarm before four engines had arrived.

wax figures in the show windows, partially concealed by smoke, for victims of the fire. These wax figures, softened by the heat, fell one by one.

The fire was finally under control at about 8 P. M. and was completely extinguished some time later.

Conclusions.

The interior of the building was completely destroyed, although some of the floors are still in place. The outside walls are still standing, but one of these needed immediate support. One of the elevator shafts fell during the fire, pulling portions of the floors with it. A similar thing happened to one of the main staircases. Although the greater part of the money loss reported was in stock, the building damage is estimated at 75 per cent. The behavior of iron and steel in this fire shows conclusively the need for protection, and the large values destroyed show the importance of constructing buildings with fire walls and properly protected floor openings. Above all, the need for automatic sprinklers is demonstrated. At the present time comparatively few buildings in Paris are equipped with sprinklers, but as a result of this fire, there is a widespread agitation for the installation of automatic sprinklers, and for more stringent building regulations for stores, theatres, museums and other public buildings where crowds gather.

Historical.

This fire has brought forth comment on previous large fires in France, especially the fire of March 10, 1881, when the old Magasin du Printemps was destroyed. The fire of 1881, caused by leaking gas, started at 5 A. M.

and destroyed the store with a loss of eight million francs. At the time a large proportion of the store employees, including the manager and his family, lived in the building. Rescues were effected with great difficulty and one life was lost.

There have been a number of other serious department store fires in Paris in the last dozen years. In 1908 the "Ville de Saint-Denis" burned with a loss of 8,000,000 francs; in 1909, "Grands Magazins d'Elbeuf," 6,000,000 francs; in 1915, the annex of the "Bon Marché," 20,000,000 francs; in 1920, "Grands Magazins de Strasbourg," 6,000,000 francs. The Magasin du Printemps fire, coming as it does after a series of serious department store fires, including a large number of less important fires as well as those mentioned, furnishes an example which should surely lead to improved practices in construction and fire protection in Paris.

Recent British Fire Tests of Concrete.

The British Fire Prevention Committee has recently carried out some fire tests of concrete floor slabs, plain and reinforced, which are of interest as an indication of the attention which is being given to the fire resisting properties of concrete in Great Britain. The British Fire Prevention Committee is now publishing the complete reports of these tests in the usual Red Book form. These will appear as Red Books Nos. 212 to 257 (some of the intervening numbers cover other subjects).

Mr. D. W. Wood, M.B.E., A. J. Inst. E., member N. F. P. A., and joint honorary secretary of the commission set up by the British Fire Prevention Committee to carry out the tests, has kindly submitted for review his paper describing these tests delivered before a recent meeting of the Junior Institution of Engineers at London.

Three "Testing Huts" were used, brick structures of which the full sized floor slabs to be tested formed the roofs. Heat was supplied by gas burners in the floors, with honeycombs of fire brick for diffusing. The slabs were tested under load, and in some cases hose streams were applied to the concrete while in heated condition. Accurate measurements were made of temperatures developed, and of deflection of the slabs. Many of the slabs tested collapsed during the tests; the deflection was taken as a measure of the value of those which survived. The results of these tests will undoubtedly be of great value to British designors; they are rather too technical to attempt to give in the QUARTERLY. It would be interesting to make a comparison of these results with the results of the fire tests of concrete columns conducted at the Underwriters' Laboratories and summarized in the October QUARTERLY by Mr. R. E. Wilson (page 164), but because the British tests were of floor slabs while the Underwriters' Laboratories' tests were on columns, the aggregates used were different, and the methods not analagous in detail, any such detailed comparison made prior to the publication of the official Red Books would be unsatisfactory.

There are, however, several points which may now be cited. One is the fact these tests conclusively demonstrate the necessity for adequate covering of the reinforcement; at least one inch cover should be the minimum. In some of the slabs tested, the rods were as near as half an inch to the lower surface, a common British practice, while American practice is to provide a minimum cover of one inch.

The rate of rise of temperature used in these British tests is slower than that as given by the curve used to govern fire tests in America. In the British tests the temperature was 900° F. at the end of the first thirty minutes, with gradual increase to 1800° F. in three hours. In tests conducted at the Underwriters' Laboratories the 30 minute temperature was 1550° F., with 1950° F. in three hours. The British tests were thus less severe and on this account comparatively poor showing made by the slabs tested would hardly have been expected. This may perhaps be explained by the fact that the reinforcing steel was in tension in the floor slabs, and lost its strength at about 1300°, while in the columns the reinforcing steel was in compression and withstood temperatures up to about 1700°. One rather surprising feature of the tests is the comparatively poor showing made by concrete with limestone aggregates, and better showing made by silicious gravel aggregates. Without further information, however, these results are not of value as a basis of design in America, for the aggregates and methods used are presumably not comparable with those found in American practice.

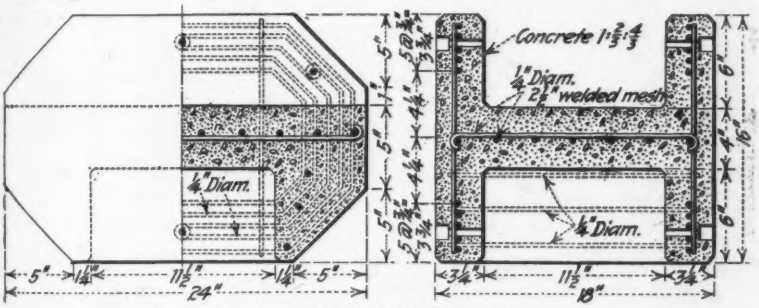
One point which will be of decided interest is the excellent results obtained with concrete using broken brick as coarse aggregate. This should make excellent protective concrete which could well be employed where broken brick is available.

Concrete Caps for Timber Columns.

Fire Tests by Underwriters' Laboratories.

By George B. Muldaur*
(Member N. F. P. A.)

In the elaborate fire tests of bare and protected building columns, summarized by R. E. Wilson (Member N. F. P. A.), in the October QUARTERLY, p. 164, it was found that timber columns stand up under severe fire exposure longer than do unprotected metal columns. However, in all cases the action of the column cap accelerated the failure of the wooden column. With either cast-iron or steel-plate post caps such as are commonly used in slow-burning mill-construction buildings, Mr. Wilson reported "the full fire resistance of the column itself is not developed" because failure occurs in the metal cap through excessive heating, crushing and brooming of the fibers, followed by slipping or failure of the cap.

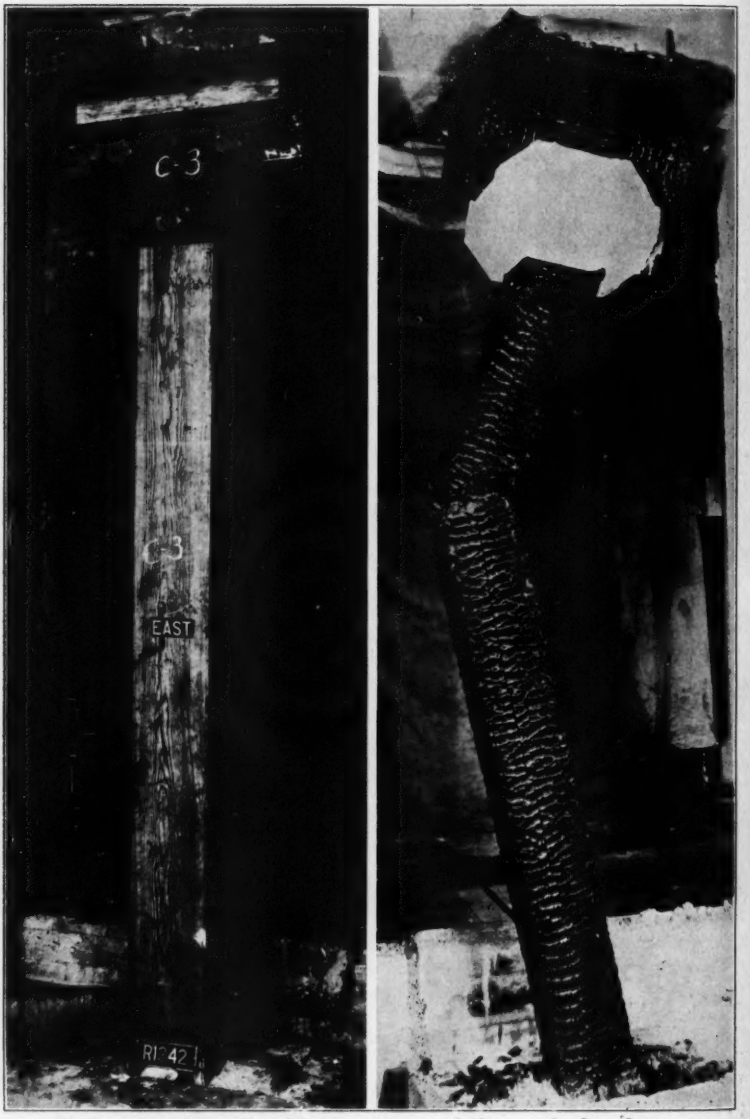


Ingberg Concrete Column Cap.

With a better form of column cap, it appeared, timber construction would show even greater superiority in fire resistance to unprotected steel or cast iron framing. S. H. Ingberg (Member N. F. P. A.) of the Bureau of Standards, subsequently designed a reinforced concrete post cap, and at the initiative of the National Lumber Manufacturers' Association a series of fire tests of posts fitted with the new cap has been carried out by the Underwriters' Laboratories, Chicago. The results justified the expectations. The concrete post cap proved itself able to develop the full strength of the timber column, and thus to double the length of fire resistance of timber mill construction. It should be added here that Mr. Ingberg has patented his form of cap and has assigned the patent to the public.

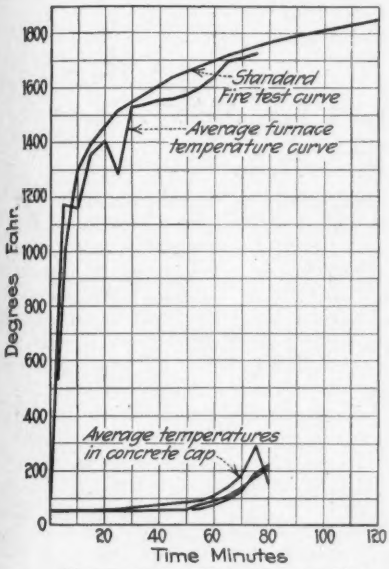
From the previous tests it had been found that 12 x 12 timber posts failed in the high temperature fire of the test furnace after 35 to 50 min.

*This article is reprinted by courtesy of the *Engineering News Record.*



Timber post (12 x 12) with concrete cap, before and after fire test.

(Under a constant load of 59 tons, about 900 lbs. per sq. in., this column stood up for 1 hr. 18 min. in the fire of the test furnace. Similar columns with steel cap failed in half that time.)



Heat Insulating Effect of Concrete Cap.

Check tests of posts of smaller section with steel caps made in connection with the new series tests gave similar results (four tests showed failure after 25, 45, 38, and 42 min.). With concrete caps, on the other hand, six 12 x 12 in. columns stood up for 84, 78, 108, 98, 94½, and 112 min., respectively. In no case did the cap fail or cause premature failure of the column; all the columns carried their load until the body was sufficiently weakened by the burning to fail, whereas in every test with steel caps failure occurred in the cap, as previously mentioned. The effect of the concrete cap is reflected in the readings of thermocouples embedded in the interior of the cap, recording the temperature at the middle of the end face of the post where seated in the cap. With steel caps the temperature at this point rose to 685° F. during the tests, while with the concrete caps the maximum temperature reached was 195° F. (see the temperature curves).

The tests were made in the special column-test furnace of the Underwriters' Laboratories, used also in the prior tests, as described in Mr. Wilson's article. Its interior, or combustion chamber, is 7 x 7 ft. in horizontal dimensions by 12 ft. high. A hydraulic jack above the furnace is capable of applying loads up to 545,000 lb. to a member contained in the furnace. The four tests with steel column caps were made on short posts, about 24 in. long. The concrete caps were tested on a similar short post in one test and on full-length 12 x 12 posts, 10 ft. 10 in. long, in six tests. The result obtained with the short posts is not included in the figures given above for the resistance periods with concrete caps, but as it was greater than any of the others, 124 min., its omission is on the safe side.

In one of the tests the lateral thrust developed by the column at the moment of failure resulted in cracking and breaking the concrete cap. This was not a primary failure of the cap, however, nor did it produce or contribute to the failure of the column. The caps carried no girder loads in the tests, as they would actually.

It should be borne in mind that any conclusions drawn from the test will be valid only for reinforced concrete caps made in strict conformity with the specifications used in making the caps for these tests. The special mixture of concrete and the design of the reinforcement are factors to be considered.

The Aluminum Industry.

By Percy Bugbee.
(Executive Assistant N. F. P. A.)

Aluminum is one of the most widespread of metals occurring in nature, but until recent years it has been exploited but little because of the many difficulties encountered in obtaining the pure metal at a reasonable cost. The industry has made rapid strides in the past decade and is now an important factor in the commercial metal field. It is quite probable that the time will come when we will pass from the steel age of the present to an aluminum age. Recent newspaper reports have it that a new process of extracting aluminum from clay at a cost of from five to seven cents a pound (present cost is approximately twenty-five cents a pound) has been invented. Should this be true there would result an enormous increased output of aluminum and many industries would be affected.

It is not the purpose of this article to give a complete report of all the phases of the industry. The thought is rather to outline the workings of the industry in a general way so that fire protection engineers may obtain an idea of the problems which will be involved as the field of aluminum becomes larger. A few typical fire reports from the N. F. P. A. fire record files are appended.

The Metal.

Aluminum is a soft white metal. It is the lightest of all the common metals with the exception of magnesium. Iron is three times and copper three and a half times as heavy. This property of lightness makes it of unusual value. The metal melts at 1215° F. It is very malleable, approaching gold and silver in this respect. It is also one of the most ductile metals, being exceeded only by gold, silver, iron and copper. It is not readily oxidized by the air and is not attacked by organic matter. Aluminum is an excellent conductor of heat and electricity. The electrical conductivity is 61.67, silver being taken as 100. On the same scale, the conductivity of copper is 97.62. However, aluminum wire, weight for weight, has a conductivity of 206, taking copper as 100. Aluminum forms many valuable alloys with other metals, notably copper, manganese, zinc, and nickel. These are some of the common properties that make aluminum of special value in industrial fields.

At present the metal is obtained from bauxite which is a hydrated oxide of alumina (Al_2O_3), mixed with some iron. Extensive deposits of bauxite are found in this country, especially in Arkansas, Tennessee, and North Carolina. The bauxite is purified by heating with sodium carbonate, forming a soluble sodium aluminate (Na_3AlO_3). Pure aluminum hydroxide is then precipitated with lime. The Hall process of reduction is largely used in this country. In this process the alumina is electrolyzed in a fused bath of cryolite ($Al_2Na_6F_{12}$). The pot, which has a thick carbon lining, forms the cathode and graphite rods, which are suspended

in the bath, form the anode. Each anode rod carries 250 to 300 amperes of current. For this reason reduction works are located near a source of cheap electric power. (There is a large reduction works at Niagara Falls.) The quality of the product depends on the grade of alumina used. Commercial grades of aluminum pig range from 90 per cent to 99.65 per cent aluminum. The metal is usually sent from the reduction works in the form of a 45 pound pig.

Melting.

In order to prepare the metal for rolling the pig is remelted, usually in a special small open hearth furnace. The best fuel is gas mixed with steam, as a careful temperature control is necessary. The temperature should be kept at between 1350 to 1400 degrees F. Any higher temperature tends to form blowholes in the ingot due to occluded gases. The common trade alloys are also prepared in the melting room. The most popular alloy for machine work and castings is of 92 per cent aluminum and 8 per cent copper. It is made by adding to the furnace charge the proper proportion of an alloy of 50 per cent copper, 50 per cent aluminum. Pure copper is never added as the melting point is too high. Another common alloy for the sheet and cooking utensil trade is a 1¼ per cent manganese alloy.

At the proper heat the metal is poured carefully into water-cooled iron moulds. The usual size of ingot for rolling is 24 x 12 x 4 inches.

Rolling Sheet Aluminum.

The ingot while still at a temperature of about 900° F. is sent through the "hot rolls," two revolving smooth steel rolls. The flow of the metal causes it to lengthen out with no change in width. The length and thickness depend on the number of passes through the rolls. The usual thickness is ¼ inch. The lubricant on these rolls in many cases is kerosene. Special non-flammable oils are also used and are preferable from a fire hazard standpoint.

At this point, the slabs from the hot rolls are divided, depending on the use to which the metal is to be put. Some of the slabs are sheared to a definite size and sent through continuous mills, a series of rolls, the metal coming out in a flat strip coil. The metal is reduced from ¼ inch to 10 gauge in the continuous mill. These coils are then sent to strip rolls and are passed through until the desired gauge is reached. This method of rolling is used because of the ease of handling long lengths of the sheet in coil form. Much of the cooking utensil metal and all of the foil metal is prepared in this form.

Slabs for flat sheet go to the rough rolls, heavy rolls with a coating of aluminum oxide. Here the slabs are gradually brought down to flat sheet and this is sent to the finish rolls for bringing the sheet down to the final gauge. Finish rolling is a monotonous process of passing and repassing sheet through smooth surfaced rolls until the required gauge is reached.

Annealing is required for the finer gauges of sheet. Internal stresses are set up during the rolling and unless annealed the metal cracks. The sheet is put in furnaces at 800 to 900° F. for from 14 to 16 hours. The harder manganese alloy requires more annealing than the pure metal. Foil metal requires four or five separate annealings. The finished sheet

is cleaned by passing it through benzine and dry sawdust.

Rolling sheet is the most difficult part of aluminum manufacture. Many defects develop and great care is needed to avoid them. Air blisters develop during annealing. Careless handling or dirt on the rolls make pitmarks and slivers.

Finished sheet has many uses. A considerable amount is used for automobile bodies and fenders. Most of the aluminum cooking utensils are formed from sheet metal. It is the basis of foil and of bronze powder.

Cooking Utensils.

Aluminum is considered to be the most satisfactory of all materials for cooking utensils. It is not attacked by foods, is light, attractive in appearance, and wears well. This branch of the industry has assumed tremendous proportions and many complicated and special machines are required. Let us follow through the process for making one standard utensil, the Windsor or preserving kettle. To start with the sheet mill provides 1¼ per cent manganese alloy annealed and strip rolled to 17 gauge. Fifteen and one-eighth inch circles are then cut from these strips. This, being a fairly deep kettle, requires three drawing operations. Drawing is done on large double action toggle presses. The flat circle is placed over a die of the required shape and a punch draws the metal down to fit the die. Aluminum will take a draw from one-fourth to one-third more in depth than copper, brass or steel. Designing of the dies requires great accuracy to prevent wrinkling or tearing of the metal. The kettle is now of the correct depth. The edges are beaded (rounded) on an automatic beading lathe and the irregularities are smoothed out over a chuck on an automatic spinning lathe. Holes are then punched for the handle. It is now in shape for polishing.

The polishing of aluminum requires four separate operations. The article is first roughed, being held against a rapidly revolving wheel made up of old felts rolled in emery powder and glue. This opens the pores of the metal. It is then oiled. For this a solid felt wheel with fine emery and a mixture of tallow and oil is used. This gives the metal a dull smooth appearance. The next operation is buffing. The buffing wheel is made up of sections of cloth buffs with Tripoli brick as the abrasive. Buffing is done by hand, the workman holding the utensil against the revolving wheel. The final operation is coloring. This is done on a very soft felt wheel with white diamond brick as the abrasive. It brings out the beautiful high polish of the aluminum. The handles and bail are attached and the kettle is ready for shipment.

Curved shapes, such as pitchers, are formed by hand spinning over a chuck on a lathe. Spouts for tea and coffee pots and kettles are welded with an oxy-hydrogen flame using a special flux of secret formula (probably a mixture of alkali chlorides and fluorides). Spout halves are stamped from flat sheet on small cam presses. The halves are dipped in flux and welded together and then the spout is welded to the kettle.

For heavy gauge ware the oxy-acetylene flame is used. A hotter flame is necessary because aluminum is so conductive that the heat is rapidly dispersed.

Some ware receives a satin finish instead of the bright polish. This finish is similar in appearance to frosted glass and may be obtained in

two ways, by scratch brush or by caustic dipping. The scratch brush is a fine wire brush and if the aluminum is held against a rapidly revolving scratch brush the satin finish is obtained. Caustic dipping is accomplished as follows: the metal is cleaned in benzine, dipped in boiling concentrated caustic soda, washed in cold water, and dipped in hot strong nitric acid. It is then washed in cold water and dried quickly.

Each utensil requires different operations or special dies so that the machinery investment is large. The finished utensils are wrapped in thin paper and packed in excelsior in shooks or boxes.

Foil.

Aluminum foil is gradually replacing lead and tin foil because of the much larger covering surface per pound of metal. The foil is principally used as wrapping for candy, cheese, tobacco, and soap. It is also used for electric condensers, tea containers, backing for pearl buttons, and for fancy flower bouquets.

Only good grade annealed pure metal is used for foil. The strip metal is rolled to 28 gauge. Foil rolls are specially designed small finely polished rolls, for the most part made in Germany. The metal is brought from 28 gauge to .006 inch and from .006 inch to .003 inch. It is then gradually rolled down to .0005 inch, which is the usual gauge for foil in this country. The rolls are run at a slow uniform speed, induction motors being used for driving on this account. The length of the coil increases enormously as the gauge becomes smaller. It sometimes requires from one to two hours for a single coil to pass through the rolls. Plain foil is interleaved with tissue paper before shipment to permit easy separation. Much of the foil is backed with wax paper when used for wrapping foodstuffs.

Bronze Powder.

Aluminum has replaced bronze as a basis of varnish powders, but the product retains the old name because of trade usage. The details of manufacture are not widely known as there are few plants engaged in this class of work. Sheet metal cut up into small squares is put into shredders for about 4½ hours. The shredded aluminum is put into stamp mills for 21 hours. The air, men, and machines are covered with fine dust. The noise in one of these mills is terrific and the workmen only stay in them to fill or empty the mills. The powder is put through sieves and then polished in cylinders with revolving brushes. It requires 18 to 21 hours for polishing the standard grade. Mutton tallow is introduced during the grinding to keep the powder flaky. Stearic acid is also added. It is believed that this tends to reduce the static electricity. Great care is taken to keep moisture from the powder as it is very hazardous when wet. The fineness of the powder varies from 140 to 160 mesh. A fine unpolished powder is made for use in fireworks.

Another dangerous form of powdered aluminum is known as pulverized aluminum. It is prepared by pouring molten aluminum in a fine stream through a small opening. An air blast is directed on the stream and sprays the aluminum into a fine powder. This powder is used for fireworks and explosives.

Grained aluminum is a coarse powder prepared by constantly stir-

ring molten aluminum until it has cooled below the melting point. It has no explosion hazard. It is used as a reducing agent in the preparation of steel and vanadium.

Tubing.

Aluminum tubing is made by two general methods. One method is by drawing from large sheet circles. A circle is cut out of a flat sheet and placed in a draw press which makes it bowl shaped. It is gradually drawn deeper and deeper until a long tube, known as a bloom, is formed. This "bloom" is then drawn over a "bulb," limiting the inside diameter, and then through a die which limits the outside diameter. Successive drawings will give smaller and smaller sizes of tubing. Annealing is of course necessary for the drawing operation. This method can be used for tubing as large as six inches inside diameter.

The other method is known as the Mannesmann or pierced billet process. A round ingot, known as a tube ingot, is poured in the melting room. This ingot is usually 4½ inches in diameter and about 3 feet long. It is heated and placed in a horizontal press, one end is firmly clamped and a die is placed at the other end. The ingot is literally pushed over the die, which comes out at the other end. The tube is then reduced to size as in the first method. The Mannesmann process is extensively used in the manufacture of copper tubing.

Extruded Shapes.

Moulding, weather strips, and other continuous shapes are formed by extrusion. Extrusion resembles the squeezing of tooth paste from a collapsible tube, the tube being the press, the opening the die, and the paste the extruded moulding. The metal may be introduced in either molten form or as a preheated billet or slug. The former method is used largely in vertical presses, while the latter method is used in horizontal presses. Where the molten metal is favored a small gas fired tilting furnace is used for melting. Where the billet is employed a continuous leer does the preheating. The operator grasps the moulding or shape, as it is first extruded from the press, with his tongs and walks away from the press slowly until the capacity of the melt is exhausted. The ribbon of metal lies on the floor until cool and is then cut to length and straightened.

Seals.

Aluminum seals are used for capping bottles, jars, and other containers. They are manufactured from flat sheet by a process of drawing and assembly, the caps being stamped out by automatic machines and the discs or liners—cork, composition, prepared mica board, etc.—are assembled either by hand or by machine. The surface of the metal is usually given a gold finish by means of special varnishes and the use of baking furnaces. The exact methods used to procure this finish is kept a trade secret. Very ingenious sealing machines are made and used for attaching aluminum seals to glass bottles and jars.

Castings.

This branch of the industry owes its rapid growth to the automobile industry. Aluminum castings are popular for cylinders and other engine

parts. Castings also find use as machine and airplane parts, vacuum cleaner parts, shoe heels, and many other products.

The 8 per cent copper alloy is almost universally used in this country for foundry work. Foreign practice inclines to an alloy containing 15 to 16 per cent of zinc. The zinc alloy gives a hard, sharp casting but is difficult to handle in the foundry because of the care required in regulating conditions.

The aluminum foundry procedure is very similar to that of any metal foundry. Great care is needed, however, in regulating the pouring temperature and in providing for shrinkage. The temperature of pouring should be slightly above the melting point and the metal should be kept at this temperature and not exceed it.

Shrinkage of aluminum is very high and proper allowance is made for this in casting work by attaching risers to the parts which solidify last. The risers remain molten longer than the casting and supply metal for shrinkage. In making up a mold the sand is rammed lightly and the mold is well vented. A snap flask can be used successfully for small work. Cores are made soft so that they will crush and prevent cracking of the casting.

Aluminum castings can be machined easily. A lubricant is necessary and for turning a mixture of 50 per cent lard oil and 50 per cent benzine is used. For general machine work any non-alkaline cutting compound can be used. Sharp-edged tools are required to prevent tearing, because of the softness of the metal.

Wire and Cable.

Aluminum wire is largely used in the manufacture of cable for electrical transmission lines. The aluminum ingot or pig is remelted and cast into wire bars (4 x 4 x 72 inches). These bars are then rolled to ⅜ inch rods by passing through grooved rolls. The rods are rough rolled to about .3 inch and then drawn to final size through dies. At the necessary intermediate points reheating is done. Most of the cable is reinforced by a steel core in the center. The wire is wound on drums and strands are interwoven around the steel core. The common numbers of strands are 17, 19, 37, and 61. For large cable the steel core is made up of strands also. The process is similar to the manufacture of copper cable.

Fire Hazards.

It is the intention of the writer to merely indicate the possible points of fire hazard as the industry has not developed to such a stage that a well defined and accurate classification of fires and their causes has been accumulated as in other industries.

The preparation and melting of the metal does not include any marked hazard as the furnace room in any plant must necessarily be of fire-resistive construction. There should be no combustible material of any sort in the melting room.

The first point of hazard in the sheet mill is the use of kerosene as a lubricant on the hot rolls. A considerable supply must be kept on hand and as it is distributed over the rolls through pipes there is always a

chance for splashing it over the floors and spreading it around. (See fire report S-21224.) As has been already previously mentioned, however, a non-flammable residue oil may be used with entirely satisfactory results. In a mill where the writer was at one time employed, the continuous mill was a source of fire hazard because of the accumulation of oily waste and paper in the pit under the rolls. Several small blazes occurred from this source. There is of course no reason for this except poor housekeeping and all parts of the mill should be kept as free from oil and dirt as possible. A light lubricating oil is used on the strip rolls and finish rolls. This oil should be kept in approved containers. There is no particular hazard involved at the annealing furnaces if of proper construction. There should be no woodwork near at hand. Cleaning sheet in benzine and dry sawdust offers a distinct hazard and care should be taken to keep any open lights away from this part of the mill. (See fire report H-10312.)

Cooking utensil manufacture has several points of fire hazard. The lubricant for the draw presses is a heavy grease as a rule but occasionally an oil is used. The surface finishing and polishing of aluminum ware creates a very fine dust which is difficult to remove even where exhaust systems are installed. In fact exhaust fans have sometimes been the cause of aluminum dust explosions because of a spark. (See fire report S-27465.) When aluminum dust is dispersed through the air in a cloud it will burn with tremendous rapidity and oftentimes explodes violently. Practically all of the polishing operations involve this dust; the scratch brush finishing process makes a particularly heavy dust. Too much care cannot be taken to reduce this hazard. Any foreign material which gets into an exhaust fan may cause an explosion. Mr. C. W. Keniston, of the Industrial Commission of Wisconsin, has designed a system calculated to remove the explosion hazard whereby the dust is removed by an efficient ventilating system working on the ejector principle with exhaust fans eliminated. Such a system would materially decrease this dust hazard. It should be noted that the only polishing operation which requires an inflammable lubricant is oiling. In this operation a mixture of tallow and oil is used.

A considerable amount of the ware is cleaned in benzine and sawdust before the final polishing operation. Benzine soaked sawdust is scattered around and will of course ignite on the slightest provocation. Practically all the metal is cleaned to remove grease or oil at one time or other during the manufacture. The cleaning agent is sometimes naphtha or other inflammable liquids and is used in considerable quantities in open troughs.

The welding room should be free from any inflammable material and the storage of acetylene and hydrogen should be outside the building and in approved containers.

Packing and shipping of utensils requires a large supply of thin paper, excelsior, and wood. The shipping room should be kept in good order and accumulations of waste paper kept as low as possible. The box factory and lumber and excelsior storage rooms should be completely cut off from other parts of the plant.

Fire hazard in the foil mill is small if the building is of fire-resistive

construction. A small amount of oil is used for lubricating the rolls and should be looked after. Some foil is not backed with paper and must be given a gasoline bath to remove the oil to prevent sticking. This process should be carried on in an isolated section of the mill and handled with care by the operators. There is always a considerable amount of wax paper and tissue paper on hand in the foil mill and scrap or torn pieces should be removed from the mill at least daily. The annealing furnaces in the foil mill should be a considerable distance from any woodwork or inflammable material.

Bronze powder mills should be isolated from buildings or dwelling houses as there is a very marked danger here of an explosion or serious flash fire. (See fire report S-22642.) The aluminum is ground to an impalpable powder which is extremely hazardous when wet. Explosions have been caused by attempting to extinguish a fire in a bronze powder mill with hose streams. This is no doubt due to the fact that hose streams stir up the dust into a cloud. This condition is of course ideal for an explosion or flash fire. The possibility of spontaneous ignition is also greatly increased when the powder is wet. Sand or some other smothering material is the best method of extinguishment. The use of open lights must be prohibited and all lights should be guarded against possible breakage.

Powdered aluminum has similar dangerous properties to bronze powder. (See fire report S-13293.) The fact that it is used for explosives indicates the care with which it should be handled. Its production at present is limited and it is only in case that the demand increases that the fire hazards of its manufacture will require special study and attention.

The annealing furnaces are the only probable fire hazard in tubing manufacture. These should always be located in fire resistive buildings and isolated from other processes. Extruded shapes and seals have no inherent hazard in their manufacture, with the possible exception of the gold finish process in seal manufacture.

The aluminum foundry is subject to the same hazards of other foundries with the exception that the melting in open hearth furnaces or in crucibles is not as hazardous as the cupola of the iron or brass foundry. The usual hazards of the core oven, hot castings against woodwork, pouring and spilling hot metal, etc., are present.

In general, the nature of the industry is such as to practically require a fire-resistive building for all the manufacturing processes. A thorough system of cleaning is necessary as in most of the operations there is a chance for dust, oil, paper, etc., to collect. Sprinkler installations would be desirable in foil and seal mills, and in foundries if of wooden construction.

It should be realized that the above is necessarily but an incomplete sketch of the workings of the industry, as a volume would be required to cover in detail all the manufacturing processes involved. The purpose is rather to suggest the possibilities of future growth of the industry. There is little doubt that it will prove a factor to be reckoned with in future industrial development.

Following are a few typical fires taken from the fire records of the N. F. P. A.

Fire Record.

S-21224. Kerosene oil at standard test, used in rolling the aluminum, is forced through a perforated pipe over the rolls by 8 lbs. air pressure on a 650 gallon tank buried outside the building. The oil is controlled by a lever near the rolls. There is a metal hood over the rolls with fan, and a fan also blows air into the pit under the rolls.

The kerosene was apparently ignited by a hot ingot and set fire to the oil and grease in the pit. Seven sprinklers opened, one of them directly over the 500 H. P., 220 volt A. C. motor driving the roll train. Upon discovery of the fire the kerosene was immediately shut off and the motor and fans stopped. The fire was extinguished by the sprinklers assisted by three private hose streams. Upon wiping up and drying out the motor with air hose, it was found that a short circuit had occurred, necessitating reinsulating two of the field coils and a small part of the armature.

H-10312. This plant was a medium sized joist construction frame aluminum ware works with open stairs and elevators and no adequate cut offs. Hazard of occupancy was considerable throughout, but heaviest hazard was located on second floor main building, where a galvanized iron tank contained benzine for washing finished aluminum vessels and a bin of sawdust was used for drying and polishing the vessels after the benzine bath. No cover on benzine tank.

The fire is stated to have been caused by a boy employee throwing lighted match into bin of benzine soaked sawdust to display his so-called "courage" before two other boys employed there. Foreman of department caught the glare of the fire and immediately seized a 2½ gallon chemical and attempted to extinguish fire, meanwhile calling to other employees to send in alarm and to come to his aid. The boys causing fire disappeared at once and left factory. Fire was communicated to benzine tank before it could be controlled and employees were driven from room. Volunteer fire department of village responded promptly and got numerous streams on fire, but spread of flames was so rapid that streams were ineffective.

S-27465. Fire and explosion occurred in the scratch brush finish room of a concern manufacturing aluminum utensils. About twenty-five girls were employed in this department and six died from burns and shock.

There is no doubt that fire resulted from an explosion of aluminum dust in the blower system attached to polishing brushes and that the explosion was ignited by a spark caused by a piece of wire becoming entangled in the blower fan. A defective condition was first noticed in the apparatus by employees working in the vicinity of the blower when the wire first came in contact with the paddles of the blower fan, causing a loud rattling. Several of these employees moved away from the apparatus, as they remembered a former explosion which did slight damage, and in all probability injury to these employees was prevented by their caution. Two master mechanics, who were working in the mill yard, report that there were two explosions, so close that it was almost impossible to distinguish them, and upon looking up toward the windows of the building they noticed flames bursting from the department where the accident had taken place.

It is quite characteristic for two explosions to occur where dust is the explosive material. In all probability there were two explosions as reported by the master mechanics. Aluminum dust has been known to be very explosive as well as injurious to life and the dust removed from the polishing benches was probably very fine and the explosion very easily set off on this account. The first explosion, which probably took place at the blower fan, was probably not as severe as the one which immediately followed.

The damage by fire and water, three sprinkler heads having opened, was comparatively small. The damage done by explosion was considerable. The east and west walls of the building were pushed outward three inches at the roof line and the glass in twenty windows damaged. The doors leading to the passage way and to the fire escape were blown off their hinges. At the time of the explosion there were 75 employees in the building and it is considered that if these windows had not been provided in the building walls that the building would have been demolished and a great many of the employees killed. The fire damage was limited to the wooden bench and the stock bin.

It is difficult to recommend conditions which will prevent a recurrence of this disaster. The explosive characteristic of aluminum dust cannot be entirely eliminated by any physical means, although it probably can be reduced in seriousness. The use of iron should be prohibited in the construction of blower pipes and for the polishing brushes, if the latter is possible. The apparatus should be constructed so that no material can be introduced into the piping by irresponsible and ignorant persons. It is supposed that the wire found wound about the paddle wheel of the blower was placed in the pipe that discharged the dust above the roof. It would be advisable to provide a small blower at each wheel, or pair of wheels, with a separate blower system so that if explosion occurs it will not involve a great amount of dust and will not spread the fire. It would also be advisable, especially if the large single unit blower fan is provided for many machines, to construct the piping as large as possible, to construct the joints with small sized rivets, and to provide explosion drums venting to the exterior of the building. There should be automatic dampers in the small piping to each brush. With the apparatus constructed as outlined, if an explosion occurs its force will be spent in blowing out the explosion heads, in shearing the joint rivets, and will not be thrown, due to the automatic dampers, into the faces of the employees operating the brush wheels. Rooms containing this process should be enclosed by walls having many thin glass windows.

The blower piping and fan enclosures should be constructed of a metal which does not easily strike sparks. The most satisfactory material may be sheet aluminum itself. The blower fan should be constructed of aluminum or bronze, preferably the former, if the metal will stand the strain.

S-29810. Buffing wheels in the polishing department of an aluminum utensil plant became heated by friction almost to the point of combustion. The plant closed at 5 P. M. and it is supposed that a buffing wheel was left smouldering and the fire was conveyed to a box of waste below the machine. The fire was extinguished by sprinklers with small damage.

S-22642. Fire occurred at 7:15 A. M. in the Aluminum Bronze Powder Department where Polishing Mills and Stamp Mills were located. Buildings were one story brick, roofs of saw-tooth type, plank on steel truss construction. The floors were concrete with board overlay. The one story building, 30 x 78 feet, used as a sifting room, had corrugated iron walls on wood frame and joisted roof. North of that building the storage building, 42 x 73 feet, was one story with brick walls on the south and west sides. The other two walls were corrugated iron on wood frame. It had plank on wood truss roof with a single saw-tooth. The plant was well sub-divided with fire walls, and had automatic fire doors at the openings between sections and in the south wall of storage building. There was an unprotected belt hole in the north wall of the stamp mill at the drive to the sifting building. The brick buildings were heated by blower system. An air duct of considerable size ran under the floor to outlets in the several rooms. The corrugated iron buildings were heated with steam, pipes at the sides. One building and the motor passage was sprinklered, heads on the dry pipe system with water on the equipment at the time of the fire. There was a vacuum cleaning equipment.

Aluminum bronze powder of several grades was manufactured ranging in fineness from that which would pass a 120 mesh sieve to a 220 mesh. Briefly described, the process was to pulverize scrap aluminum in the stamp mills. The product was graded for size in the sifting room, after which it was polished in rotating cylinders. The finished bronze powder then went to a storage building where it was packed in cans and drums for storage and shipment. There was some stock in open boxes awaiting packing. The story of the fire is as follows:—

The morning of the fire a supply of some of the ingredients used in the manufacture having run out the machinery was not started, and two of the men were set at work in the sifting room to tear down an old brick core oven. There was an accumulation of fine aluminum dust on top of this oven, and at the second blow of the sledge a spark was struck which ignited the dust. One of the workmen on top of the oven was burned before he could get down. The fire spread in the aluminum dust on top of the oven. The men as quickly as possible gave the alarm to the foreman, who was in his office, and he hurried to the scene, and endeavored to extinguish the fire by the use of sand pails. Incipient fires in this material are most effectively extinguished by smothering with sand. The fire was located in an awkward place to reach and in spite of the efforts of the men it spread, reaching the roof, and attacking the machinery in the room which was of wooden construction. Finding that the fire was getting away, a call for assistance was made, and some of the machine shop force responding tried to use sand on the fire, but by that time it had reached such proportions as to be out of control of this method of extinguishment. The whole building was soon on fire. Some members of the mill force laid a line of hose and used a stream on the passageway between sifting building and the storage building, with the idea of keeping the fire out of the latter. Fire doors were closed and a dam of sand was placed around the under side of fire door between the stamp mill and the sifting building. The Town Fire Department had been summoned and on arriving laid other hose lines, and it is said used one

stream in the burning sifting building, although cautioned that the use of water on aluminum powder in a finely divided state was dangerous.

In the meantime the belt between the sifting room and the stamp mill had been cut, but fire undoubtedly spread back through this opening and attacked the dust on structural members of the roof. It is stated that two sprinklers were open in the building about that time. The mill fire department, and perhaps some of the town firemen, entered the stamp mill with a line of hose, and probably some water was put on from this line, but almost immediately an explosion took place which badly burned these men so that seven died soon thereafter, and fifteen others were severely burned. A few minutes later a more severe dust explosion took place in the underground heating duct which wrecked two buildings in part, the effects of the explosion being particularly manifested wherever there was an outlet for the heating system. The first explosion probably lifted the roof of the stamp mill and broke off the sprinkler system, which was shut off about that time, and the fire having a free play almost completely consumed the woodwork of the stamp mill. The force of the explosion, particularly the second one, damaged many sash and large amount of glass in adjoining buildings. The storage building stood until about 11 o'clock when fire attacked it, probably through the roof, and it burned until completely consumed.

The first of the explosions referred to above took place about 8 o'clock, and the second and more severe one about five minutes later. After that time the firemen were afraid to approach the plant so that practically little was done in the way of fire fighting and the fire virtually burned itself out.

S-13293. A wood frame iron lined tower was used for making powdered aluminum. The top of tower was flush with a cast iron platform on which was a rotary melting furnace. The molten aluminum was taken from this furnace and poured into the iron nozzle on top of tower, and a stream of compressed air converted the aluminum into a powder. The air and dust discharged through an outlet on the side to a separator which caused the dust to drop into a metal collector and the air vented into the room. The powdered aluminum was drawn off near the bottom of the tower as desired.

It was claimed that some of the molten aluminum accidently came in contact with the wood frame work of the outside of tower, igniting same. The fire rapidly destroyed the tower and it is said that there were two or three slight explosions from the aluminum dust. The chief engineer of the plant was nearby and he directed the work of extinguishing the fire. One 1⅛ inch stream from a yard hydrant was used, and one carbon tetra chloride extinguisher, the latter being utilized in putting out a fire which was spreading through some open power and light wiring overhead. Care was taken not to use the water from the hose line injudiciously, and a 75 H. P. motor on the platform near the tower was not at all damaged. The tower, however, was entirely destroyed with its contents, which consisted of 1000 lbs. of powdered aluminum. The corrugated iron roof was damaged immediately over the fire, and it was necessary to replace the corrugated iron over an area of about 25 x 45 ft. The steel purlins and steel trusses were not damaged, except for the burning off of the paint.

The Augusta Conflagration.

Extracts from Report by Southeastern Underwriters' Association.
(Member N. F. P. A.)

A fire which occurred early in the morning of November 26, 1921, destroyed or damaged about half a block in the business center of Augusta, Georgia. Four buildings were totally destroyed and five more badly damaged. It is estimated that the loss will be between a million and a million and a half dollars.

In general, all buildings were of brick construction with unprotected openings in exterior walls; numerous frame and plaster on wood lath partitions, concealed spaces in floors, partitions and ceilings, floors of boards on joists, mostly of light construction, with unprotected floor openings. The roofs were ordinary joisted, covered with composition or metal. The five story White building, at which the fire was stopped, is brick, mill construction, with all exposed openings protected by tin clad shutters and is equipped with automatic sprinklers.

Story of the Fire.

The fire was discovered about 1:45 A. M. on the fourth floor of the Harrison Building on Broad Street. It is reported that a club or social meeting was in session on the fourth or fifth floor and it is possible that a carelessly dropped match or cigarette was the cause. An alarm was turned in at the nearest box and five companies responded. Immediately upon arrival the chief turned in a general alarm. The fire made rapid headway on the fourth and fifth floors of the building and although several streams were soon brought to bear on the fire, it spread rapidly to all floors, due to the light construction and poor repair of the building and the unprotected floor openings. Hopes were at first entertained that the fire would be confined to this building, but about an hour after the start, the west wall fell, cutting the Johnson Building nearly in half and knocking out the Eighth Street wall. The fall of this wall carried the fire into the Johnson Building, where it spread rapidly. A drug store was located in this building and the nature of the contents probably aided the spread of fire. A few minutes after the west wall fell, the top of the east wall fell into the Albion Hotel, carrying fire down to the first floor and into a drug store. The contents of this store, together with the furnishings of the rooms above, naturally aided the spread of the fire. At about the same time that the east wall fell, the rear wall went down, spreading the fire into the three story Chronicle building in the rear. After the west wall of the Johnson Building fell, the fire spread across Eighth Street to the Genesta Hotel building. The cornice and a frame, metal-clad pent house over the elevator shaft caught. The elevator fell, carrying fire to the first floor. The Aiken, S. C., company, which had just arrived, and a local company directed their efforts to stopping this fire

Courtesy of Fire and Water Engineering.

The ruins of the Albion Hotel. The fire was stopped at the White building (on left) protected by tin clad shutters and automatic sprinklers.

and succeeded by hard work in confining it to a very small area. After the Albion Hotel caught, the Augusta firemen made a stand at the J. B. White Building, to prevent the fire spreading to the east. This building is a five-story, mill constructed, brick building, equipped with automatic sprinklers and tin-clad shutters on exposed openings, and although the wood fillers of the shutters were burned out and the intense heat opened the sprinkler heads nearest the wall, the fire was checked here, this building suffering little fire damage.

There was very little wind during the time. The records of the U. S. Weather Bureau Station, located about three blocks from the fire, show that the direction was from the northeast during the entire fire and the average velocity was five miles per hour. The maximum velocity was 9 miles per hour, which occurred from 3:08 to 3:15. This is the time the fire crossed Eighth Street.

During the fire thirteen streams were used from six engines, located at as many hydrants. These hydrants were all within 400 feet, but on account of the heights of the buildings involved, the lines were considerably longer. An engine was moved just before the Johnson wall fell. The hydrant at which the engine had been working was covered up as was several lines of hose. The department was handicapped considerably by lack of hose. All nozzles used were 1⅛ and 1¼-inches. The water supply was ample and the pressure sufficient, the records showing that it

never dropped below 45 pounds. About 4 o'clock the waterworks superintendent opened the pressure regulating valve on the 24-inch gravity supply lines and the pressure soon went up to above 60 pounds. The superintendent states that he did not open this valve sooner as all of the engines had 40 to 50 pounds on the suction gauge and were getting ample water.

The fire was under control about 4:30 A. M. and some of the engines were shut down and direct hydrant streams used. The fire was practically extinguished at 9:15 A. M.

Soon after the fire started it was feared that it would get beyond the control of the local department. Requests for outside aid were sent to Macon, Savannah, Waynesboro and Atlanta, Ga., and Columbia, Charleston and Aiken, S. C. Aiken was the only company to arrive, the others being stopped either before actually leaving their city or en route.

At the height of the fire a blaze was discovered in the rear of a building two blocks away. This fire started on the first floor and rapidly spread to the second floor, which was almost completely destroyed, while the first floor suffered most from smoke and water. It seems very improbable that this fire, two blocks from the main large fire, could have been started by sparks, although the wind was in that direction. This was a moderate sized, two story, ordinary joisted brick building with a metal roof. The fire in this building originated inside, according to best information. Two lines of hose were used on this fire, which interfered considerably with work on the large fire, coming as it did when every available man and hose line was sorely needed.

Conclusions.

The rapid spread of the flames may be directly attributed to the weak construction of the buildings involved. Two buildings were of excessive height and area for the type of construction used and the others were of large area with practically no fire divisions. The walls of the Harrison Building (in which the fire originated), either from weak original construction or from weakening since being built, failed, and instead of acting as a fire retarder as intended, actually spread the fire. The group of buildings burned, while to all intents separate buildings, were almost as one, due to unprotected exposed openings and unprotected communications.

The fire department was handicapped by lack of hose, it being necessary to shift lines from one place to another. Water supply was ample and pressure good.

The Seamless Rubber Company Fire.*

An interesting fire occurred on December 1, 1921, in the dip tank room of the Seamless Rubber Company, New Haven, Conn. The fire starting in a naphtha cement tank on the top floor of a sprinklered reinforced concrete building spread to many other tanks containing about 20,000 gallons of cement, and caused collapse of the roof and columns. The fire was confined to the room in which it started.

This fire gives much interesting data as to the action of fire in large batteries of dip tanks holding inflammable liquids, the effect of sprinklers and hose stream protection, and the degree of resistance of reinforced concrete construction to long continued high temperatures.

Construction.

The plant, which was built in 1920, is of the most modern type of fire resistive construction. It consists of three buildings 240 feet long by 60 feet wide, separated from each other by spaces of 60 feet. At the end of each building a space 20 feet wide, extending entirely across the building, is devoted to service stairs, elevators and toilets. The service areas are connected at the third, fourth and fifth stories by means of enclosed reinforced concrete bridges.

The construction throughout is of reinforced concrete (1:2:4 trap rock concrete) with brick spandrel walls under the windows, steel sash glazed with ordinary glass, tile partitions and fire walls, plastered on both sides with cement plaster. The floor design is a typical two-way reinforcement flat slab with drop panels supported by round interior columns. The columns are spaced 20 feet on centers each way, dividing the building into twelve bays longitudinally and three transversely. The roof is a 6-inch reinforced concrete slab with tar and gravel covering and having reinforcing rods 1 inch from the surface.

Equipment and Process.

The dipping room where the fire occurred is on the top floor of one of the end buildings and occupies an area of 160 feet by 60 feet. The room was used for dipping rubber gloves, nipples, etc., and contained forty tanks of naphtha cement. There were thirty-two large steel tanks (750 gallon capacity) and eighty smaller tanks (200 gallon capacity), some of which were of wood, metal lined. Tanks were filled to an average depth of some 18 to 20 inches. Tanks were fitted with hinged wooden covers which were kept closed except during the actual dipping process. Forms on metal racks were dipped manually and allowed to dry above the tanks between dippings. There were hoods over the tanks but these were not in use; ventilation was by a system discharging air into the room 4 feet from the floor and taking it out at

* This report is abstracted from independent complete reports prepared by R. E. Wilson (Member N. F. P. A.) Engineer of the Factory Mutual Laboratories, and W. D. Milne (Member N. F. P. A.) of the Underwriters Bureau of New England.—Ed.

General view of damaged building from southwest. Fire started in dip tank near center where destruction is most complete. Exterior columns were pulled over by roof slab after collapse of interior columns. Roof house in rear is Cement Storage Room with Churning Room below, both uninjured, the latter cut off from Dipping Room by blank 5 in. tile and plaster wall only.

the floor level. The cement was mixed in steel drums in the churning room, pumped to the storage room above and flowed by gravity through pipes to the dipping tanks which were filled as often as necessary. It is estimated that there was about 20,000 gallons of naphtha cement in the various tanks at the time of the fire.

It should be mentioned here that neither the owners or their engineers contemplated such a hazardous process when the building was designed. Good practice dictates that any such concentration of hazardous processes be isolated in a low detached structure. Because of the expense involved in building a new structure, however, it was decided to locate the processes in the main building. This was done in spite of the protests of insurance inspectors. Aside from the location, several other features were open to criticism. The excessive number of dip tanks in a single area, the system of gravity feed, the ventilation system without fire screens, and the lack of heavy automatic covers for the tanks all presented severe hazards.

Fire Protection.

The plant is equipped throughout with a modern automatic sprinkler system supplied by (1) a 100,000 gallon gravity tank on a 135-foot trestle (75,000 gallons reserved for fire service), (2) a 1000-gallon Underwriters' steam fire pump draughting from a 100,000-gallon cistern filled by a 6-inch connection to city mains, (3) an 8-inch connection through two 6-inch connections to 8-inch public main under 30 to 40 pounds pressure. A steamer connection is also available. Sprinklers in general are spaced 10 feet by 10 feet under smooth ceiling construction. The equipment of fire pails, chemical extinguishers, small hose, and standpipe hose is quite complete. Public protection by paid department having ample motorized equipment is available, its capacity limited to a certain extent by low pressure of the public water supply.

Story of the Fire.

The fire started at 8:26 P. M. in one of the large tanks on the south side. It is said to have been caused by a static spark just as a dipping was being removed. There were two men in the room at the time and they immediately covered all open tanks, closed the fire doors, shut off ventilating fans, turned on the steam extinguishing system and gave the alarm through the plant A. D. T. system. This was quickly followed by a public alarm and the fire department arrived at 8:35 P. M. and soon had hose streams on the fire from the bridges at each side and from the fifth floor of the building 60 feet distant. These were supplemented by streams from an aerial tower on the north side. The first heavy hose streams broke the glass of the windows on the south side and probably prevented an explosion of the naphtha vapor. The tanks took fire comparatively slowly and all were not ignited until about two hours after the fire started. The water from the hose streams and sprinklers served to overflow the tanks and after a time naphtha was floating over the entire room. It is believed that 20 inches of water covered the floor.

After about three hours the roof and columns collapsed in the vicinity of the tank where the fire started. The heat was very intense at

Storage Room with Churning Room below, both uninjured, the latter cut off from Dipping Room by blank 5 in. tile and plaster wall only.

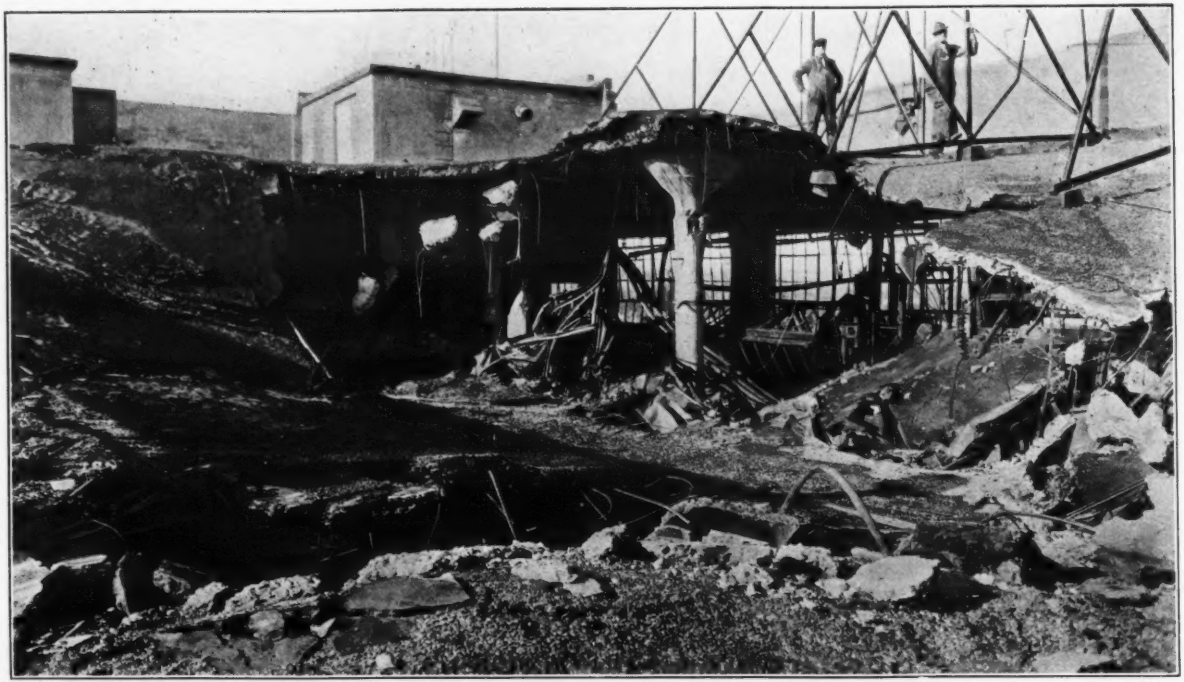
General view of building roof looking west. The north side on the right remains intact probably due to action of hose streams and the heat insulating properties of the concrete at points where the heat was not sufficient to cause failure of the slab. The collapsed roof was over the area of greatest concentration of the dip tanks.

this time, breaking windows 60 feet away. The fire continued to burn with intensity until about 3 A. M., after which it gradually burned itself out being totally extinguished at 8.30 A. M. It was confined to the dipping room, no fire passing into the churning room at the rear or service area at the front. The floor was apparently uninjured. The large amount of water on it protected it from heating and consequent expansion that would probably have done more damage to the building. The depth of water also prevented the naphtha which was floating over the surface from running out through the scuppers and under the fire doors. The water tightness of the floor was very strikingly shown by the fact that even with some 18 inches of water on it there were no signs of leakage except at one hole covered by a steel plate and at two fine longitudinal cracks in the center. The partitions at the ends of the room came through the fire in remarkably good shape. They were of 4-inch terra cotta tile with one half inch coats of cement plaster on both sides. Hose streams were played on the partitions throughout the fire. This undoubtedly helped prevent further spread. The standard tin clad fire doors at both ends fully protected the openings. The swinging doors in the west partition were all operative after the fire.

The general effects of the fire may be seen from the accompanying illustrations. Ten of the interior columns collapsed and the four remaining all show severe heat effects. The roof, as can be seen, is still attached to the north wall which was little affected throughout its entire length. There was evidence of severe expansion of the roof at the front or west end of the building. A partition wall of concrete was cracked vertically in two places. The columns which could be observed were practically free from spalling or cracking except in the regions of failure. This is typical of the action of trap rock concrete columns in the column tests at Chicago. The concrete was disintegrated in the columns examined to depths of from one and a half to three inches, exposing the steel reinforcement which had buckled in some cases. No signs of fusion were noted but the columns which had received the worst exposure were inaccessible. The columns were designed with a very large factor of safety and even assuming the strength of the reinforcing rods gone and the concrete disintegrated to a depth of 3 inches, the stress in the concrete core remaining due to axial loading would not be excessive. There was, however, undoubtedly a very severe horizontal thrust exerted at the top of each column by the expansion of the roof slab as it became heated under the intense fire. This would produce large bending stresses in the columns, which would be the greatest at the two points where failure generally occurred. The columns at the same time were being weakened by the extremely intense heat; it is thought that one finally failed under the combined loading and took the roof with it. This undoubtedly caused severe eccentric loading of the adjacent columns in addition to the other stresses and the result was a progressive failure of all the interior columns except the four at the ends where the heat was not so intense. As can be seen in the illustrations the roof slab was quite generally broken up and disintegrated on the south side of the middle section.

It might be supposed that the water from the sprinklers would have had more of a cooling effect on the roof and retarded failure. One

hose streams and the heat insulating properties of the concrete at points where the heat was not sufficient to cause failure of the slab. The collapsed roof was over the area of greatest concentration of the dip tanks.



Interior column at west end. This column is almost ready to collapse and is probably typical of the method of failure of the other columns. The 2 in. covering over the reinforcement is disintegrated and spalled near the top exposing the rods which are ready to buckle. Note absence of cracking or spalling elsewhere in column. Collapsed roof in foreground covers area of greatest concentration of dip tanks.

hundred and twelve sprinklers opened in the dipping room and twenty-eight in the churning room. This made a total of 140 heads, and assuming a maximum pumping capacity of 1200 gallons per minute there could not have been an average discharge of much more than 8 gallons of water per head. This would mean a pressure of not more than two and a half pounds at the head for at least half of the sprinklers, which would be of very little value in protecting the ceiling from such intense heat.

Conclusions.

The fire strikingly illustrates the value of good reinforced concrete construction in confining a very severe fire to one area. It is, however, apparent that even this type of construction cannot withstand the action of so severe a fire over so large an area. The remedy therefore is in so arranging and protecting so hazardous an occupancy that a fire of such intensity will be prevented.

For an occupancy of a nature similar to that which existed in the dipping room, the following recommendations are made:

(1) The process should be carried out in an independent building one story in height and sub-divided into areas not greater than 3000 square feet.

(2) The dip tanks should be furnished with automatically closing, tightly fitting metal covers and provided with drains to permit discharge of contents to a safe location outside the building. Metal hoods with an adequate ventilating system should also be installed over the tanks.

(3) An approved foam extinguishing system should be installed to protect each tank.

Fire Record — Newspaper Plants.

The fire record files of the N. F. P. A. include, under the general classification of Printing and Lithographing Plants, one hundred fires in newspaper plants. An analysis of these fires, recorded in the tables below, gives some interesting data on this class of property. Sixty-five per cent of these fires are due to common causes. Matches—smoking is the largest single cause. Most of these fires occurred in mailing or paper storage rooms. It would seem obvious that smoking should be strictly prohibited in all parts of a newspaper plant. Only two or three of the fires occurred in the press rooms, indicating that no smoking rules are in force in that section. Other common causes are responsible for about half of the fires; they do not require special comment.

Type metal furnaces and melting pots are the most prolific source of special hazard fires. In many cases these are small pots connected with linotype machines. Care of these pots is apparently neglected as fires from soot or dirt in the flue or vent pipe are common. A number of these fires were caused by inadequate protection of surrounding woodwork. Most of the sprinklered fires were of minor importance, the sprinklers being either not a factor or extinguishing the fire with one head opening.

...ture of the other columns. The 2 in. covering over the reinforcement is disintegrated and spalled near the top exposing the rods which are ready to buckle. Note absence of cracking or spalling elsewhere in column. Collapsed roof in foreground covers area of greatest concentration of dip tanks.

Sixty-one per cent of all the fires were of small loss. The largest loss recorded was a little under one hundred thousand dollars. This occurred in an unsprinklered plant.

Classification of Causes.

Common Causes.

	No. of Fires	
Matches—Smoking	24	
Heating	11	
Defective Electric Wiring	9	
Spontaneous Ignition	4	
Hot Ashes	3	
Sparks from Combustion	3	
Defective Flues	3	
Rubbish	3	
Explosion of Gas Engine	1	
Misc. Known Causes	4	
	—	65

Special Hazard Causes.

Type melting pots	9	
Soot in flues of melting pots	8	
Explosion of gasoline used to clean type	3	
Printer's ink, naphtha in ink took fire	1	
Printer's ink, friction of rolls caused fire in ink wells	1	
Asphaltum boiling over	1	
	—	23
Unknown	12	
	—	12
Total		100

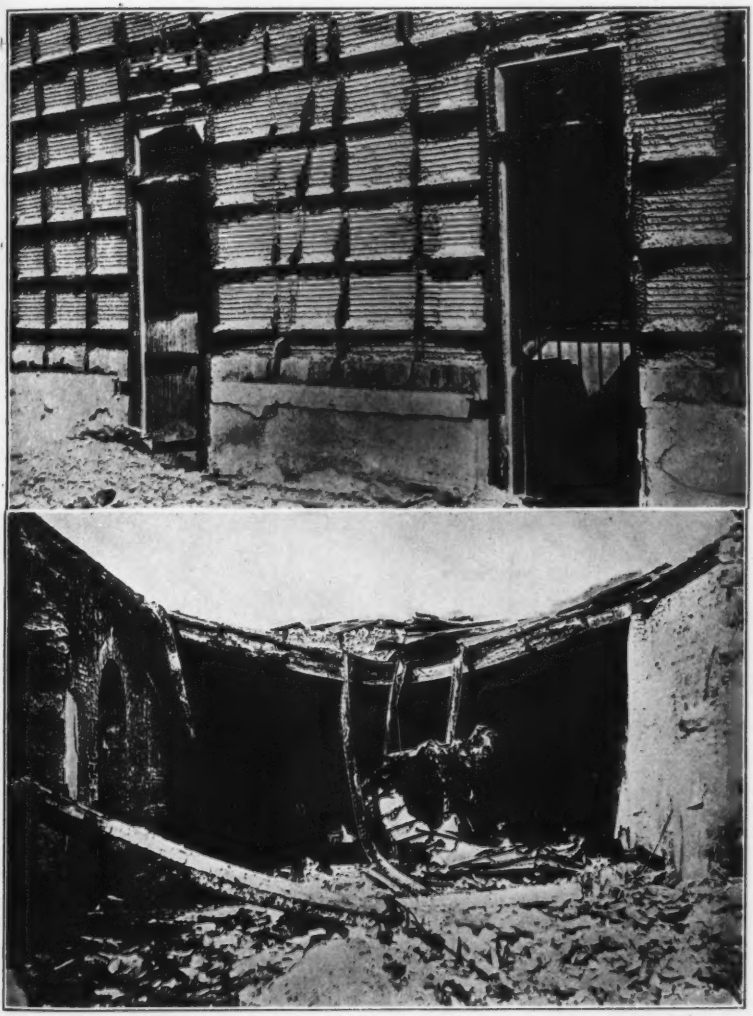
Loss Data.

	Sprinklered	Unsprinklered	Total
Loss Less $1000	38	23	61
Loss More $1000	2	37	39
No. of Fires	40	60	100

Sprinkler Record.

Effect of Sprinklers.	No. of Fires
Extinguished Fire	17
Held Fire in Check	4
Failure	3
Not a Factor	16
	40

Number of Heads Opened.	
Heads	No. of Fires
1	17
2-5	6
6-10	1
	24



Photographs by Wharton Clay (Member N. F. P. A.)

Two houses in Colon, Panama, after a conflagration which destroyed 22 stores. The two buildings were adjacent—the lower picture showing collapsed structural steel indicates the severity of the fire. The building shown in the upper picture had single walls of metal lath and cement plaster (not back plastered). The walls were still standing after the fire although much of the wooden studding was burned away and all the rest of the building had fallen.

The Rialto Theater Fire, New Haven.

A fire which broke out in the Rialto Theatre, New Haven, at 7 P. M. on Sunday, November 27, 1921, caused the death of seven and the injury of many more of the audience.

The building was an old wooden structure, formerly a church, but in recent years taken over as a moving picture theatre. There had been no change in the construction of the building when occupied for this purpose. It consisted of a basement and one high story, 60 ft. x 100 ft., with joisted floor and roof, supported by heavy wood trusses. The balcony was of frame construction supported by wooden posts. The building formed one single fire area as the stage was not cut off, even by an asbestos curtain. The heating boiler was in the low basement directly under the open joist orchestra floor and not cut off. Window openings were protected on one side only. The tin clad shutters on these windows failed under the intense heat of the fire. The building was unsprinklered and the only inside protection was a few chemical extinguishers. It is believed that one of these used by a stage hand at the first sign of fire failed to operate.

The above combination was certainly sufficient in itself to cause trouble, but the last straw came on the evening of Sunday, November 27, 1921. To provide atmosphere for an oriental production, the stage was draped with flimsy inflammable gauze and burning incense provided. The theatre was packed to the doors and several hundred persons were waiting outside in the lobby for a second performance. At a few minutes past seven the incense and draperies came in contact and in an incredibly short time the flames had gained rapid headway, spreading out over the heads of the audience. Panic and a jam at the exits ensued. There were exits on three sides of the building. Everyone, however, rushed to the rear. One of the balcony fire escapes passed a window on the first floor and when the flames broke out of this window no one could pass down. Two people were found dead on a fire escape and two more died before they reached the hospital. Three died later from burns and injuries inflicted by the mob. Hundreds of others received burns and bruises.

The building was completely destroyed in about two hours. The fire spread to a three story brick building adjoining. This was also badly gutted, but a fire wall prevented further spreading of the fire.

Conclusions.

This fire is a striking example of criminal negligence. That such a fire trap should be permitted is a discredit to the city of New Haven. It is remarkable that there was not greater loss of life. That a fire will

International

Seven were killed and seventy-five injured in the New Haven motion picture theatre fire Nov. 27, 1921. The wooden building, a converted church 100 years old, had not even an asbestos curtain. The old story of panic and jam at the exits was repeated, although the audience was of a high order of intelligence, including many Yale students.

occur under such conditions of construction and protection is almost inevitable. As usual, city officials are investigating the matter and inspecting conditions in other local theatres as to provisions made for safeguarding and preventing fires. It is always so—*after the fire.*

New York Tenement Fire; 11 Lives Lost.

Report by F. J. T. Stewart.
(Member N. F. P. A.)

A fire at 108 West 17th Street, New York, on November 14, 1921, cost the lives of eleven people. The five story building was of ordinary brick construction with joisted floors, wooden lath, plaster and metal ceilings and metal roof. Floor openings consisted of one flight of stairs in lath and plaster hallways. Partitions were of lath and plaster. The basement was occupied as a carpenter shop, the first story as a wholesale dry goods and a lunch room, and the second to fifth floors as apartments. There were two apartments on each floor, both extending from front to rear.

The fire started shortly after 3 A. M. from unknown cause. It was believed to have started in a baby carriage at about the middle of the stair hall on the first floor.

The fire spread up the stairway to top floor where it mushroomed and broke through the roof, practically burning out the greater part of the fifth story. The fire apparently spread from the hallway through a door left open on the fourth floor to the front on the west side of the hall and did considerable damage. On the first, second and third floors, the fire was practically confined to the stair hall. The stairs were burned away from third to upper floors and roof, leaving stringer beams only; the treads and risers from first to third floor, while badly burned, are still usable.

Alarm from a street box was sent in by an outsider at about 3:06 A. M. Three more alarms were sent in later by the fire department. The fire lasted two and a half hours and was fought entirely by the City Fire Department, using high pressure service; one engine company fighting the fire up the stairs and others from the rear fire escape of building and roofs of adjoining building. Except for the eleven people on the fourth floor who could not be reached in time, the occupants were all taken out by the firemen.

The loss of life which for the extent of this fire was large, was confined to the fourth floor on which there were nineteen people at the time; eight in the east and eleven in the west apartment. Three men, two women and a child were found, burned to death, in the west, and two men and one child in east apartment, the child residing in the west apartment. One occupant of the east apartment jumped to the street and an occupant in the west apartment was removed unconscious; both of these died later in the hospital. The fire completely cut off escape by way of the stairway but no attempt was made to use the rear fire escape by the occupants who lost their lives. This fire escape was available at all times.

Eleven lives were lost in this New York tenement fire. The wooden stairs enclosed only in wooden lath and plaster partitions (picture at left) quickly burned out. The fire escape at the rear of the building (picture at right) though steep and precarious was available for exit throughout the fire, but because of panic was not used by the occupants.

The property loss was heavy on the fifth floor and considerable on fourth; through the rest of building the loss is practically confined to the stairway which is badly damaged. Water damage throughout was considerable.

The loss of life seems to have been due principally to panic, a condition which can only be overcome by an educational process. Most of the occupants were foreigners. Although the fire cut off the stairway, the rear rooms from which the fire escape was accessible at the fourth floor are now in fair condition and had the occupants gone directly to the rear, probably all could have been gotten down the outside fire escape, although it was of an old type with steep (60°) ladder between balconies. At no time was the fire escape cut off by fire at the rear windows.

Weehawken Pier Fire.

Report by Chas. H. Fischer.

(Member N. F. P. A.)

Fire in the Weehawken terminal of the Erie Railroad at Weehawken, N. J., on November 3-4, 1921, destroyed four piers, two buildings on land, twelve barges and sixteen freight cars. As there were no other combustible structures in the path of the fire, it finally burned itself out, with a loss of more than two and a quarter million dollars.

General.

The terminal includes a large freight yard, the marine yard, two the extreme south end of Weehawken, adjoining Hoboken. A large freight yard is located between the piers and the foot of a cliff. It is accessible by one road (Baldwin Avenue) at the north end; distance from railroad crossing to Hudson Boulevard about 900 feet.

The terminal includes a large freight yard, the marine yard, two mooring docks, three open piers, five covered piers, three boiler houses, one four-story brick and frame building, and one one-story iron clad warehouse. All of the covered piers were of frame construction, two stories high, except that one pier was one-story.

An examination of the diagram will show that the piers involved are separated by slips 125, 195, and 142 feet wide. The integrity of such fire break as was formed by the 125-foot slip between Piers "C" and "D" was destroyed by the twenty-two barges (mainly with frame housing) moored in this slip. The four-story brick warehouse located along the bulkhead and spanning the full width of the slip between Piers "B" and "C" was connected to Pier "C" (about twenty-five feet distant) by a wooden bridge on the second floor. The portion of the wall exposed to Pier "C" was of frame construction covered with asbestos board. Pier "B" was but 35 feet from this building.

Construction.

PIERS "A," "B," "C," AND "D": SLIPS—Between "A" and "B" 142 feet; between "B" and "C" 196 feet; between "C" and "D" 125 feet. HEIGHT—Two story, except Pier "A" one story. SIZE—"A," 71 x 654 feet; "B," 71 x 684 feet; "C," 100 x 707 feet; "D," 100 x 778 feet. SUBSTRUCTURE—3-inch planks on heavy wood rangers with cross bracing on open piles. A single depressed track on each pier. WALLS—Frame on studding except that the south side of Pier "A" was open. ROOFS—Gravel and composition on 1-inch boards on 1-inch trusses and posts. FLOORS—Other than pier deck, 2-inch tongue and groove plank on heavy joists on unprotected steel girders on wood columns except that wood beams support second floor of Pier "B." FLOOR OPENINGS—Stair at each end of each 2-story pier enclosed in wood sheathing; also open elevators with self-closing traps, and in addition open barrel conveyors on "C" and

"D" with hand-closing traps. SKYLIGHTS—None. LIGHTING—Electric incandescent only. POWER—Steam engines for elevators and conveyors on "B," "C," and "D"; steam from outside source. OCCUPANCY—At time of fire, "A," 13 cars of lubricating oil in drums and cases, 1 car acetate of lime, 1 car lumber, 1 car waste paper, 2 cars of ammonia sulphate; "B," 2 cars ammonia sulphate, 1 car talc, 5 cars salt, 3 empty cars; "C," 70 cars flour in bags and barrels, 1 empty car; "D," 103 cars flour, 7 cars extract of quebraco, 1 car cocoanut, 16 cars loaded with flour (pulled out after fire started but destroyed). FIRE PROTECTION—Standpipe system with 3-inch line on "A" and "B," and 4-inch line on "C" and "D," three to six 2½-inch hose connections on each floor with 50 to 100 feet of 2½-inch hose and nozzle attached. Good supply of casks and pails in pier sheds and on roofs; also some hand extinguishers. WATCH SERVICE—Watchman with approved clock on duty nights, Sundays and holidays for each pier. Signal oil lanterns. LOCOMOTIVES—Not allowed on pier.

WAREHOUSE "C" ANNEX: Located along bulkhead between Piers "B" and "C" and connected to "C" by frame passageway. SIZE—Irregular shape, about 40,000 square foot area. HEIGHT—4 stories. WALLS—Part brick and frame covered with corrugated asbestos boards; brick walls were badly cracked. It is quite probable that the frame walls were erected to replace brick walls which failed on account of poor foundation. FLOORS—Ordinary joisted construction. ROOF—Gravel and composition on 1-inch boards. FLOOR OPENINGS—Numerous stairways, elevators, barrel hoists, well holes, and belt openings; mainly improperly protected. OCCUPANCY—Occupied by Raymond Hadley Corporation, flour blending, repacking, shipping, and storage; also for the storage of records of the Erie Railroad. At time of fire contained 9 cars of flour and 3 cars of meal. FIRE PROTECTION—Good supply of casks, pails and extinguishers well distributed. WATCH SERVICE—Watchman with approved clock on duty nights, Sundays, and holidays.

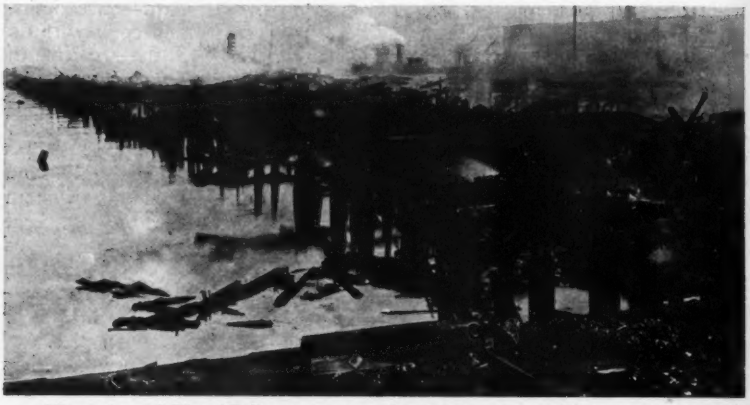
FLOATING EQUIPMENT: In the slip between Piers "C" and "D" there were 22 barges, moored mainly at the north side of Pier "D." These barges were of wooden construction and had a wood housing about 10 feet high.

Fire Protection.

OUTSIDE PRIVATE PROTECTION: WATER SUPPLY—Consists of a 6-inch wrought iron line laid along the bulkhead; this is a very old line and in poor condition. It is supplied at each end through a long 6-inch main from the Weehawken distribution system. There is a closed gate valve in this line at the head of Pier "C," the north side being under a pressure of 40 pounds and the south side under a pressure of 65 pounds. Yard hydrants with two 2½-inch outlets are located generally one within 40 feet of each pier. HOSE REELS—Two 55-gallon chemical engines and two hose reels with 600 feet of 2½-inch hose located on Pier "F," and in Warehouse "C" Annex; all hand drawn.

FIRE BRIGADE: During the day time four companies of 24 men each organized among the employees and at night time one company of 10 men are available for fire duty. During winter season drills held monthly and during remainder of year weekly.

FIRE ALARM SYSTEM: Entire terminal covered by a private fire



The ruins of Pier "D," a two-story frame structure. Fire starting on the middle of this pier destroyed three adjacent piers before it was controlled.

alarm system of the open circuit type. This consisted of an overhead circuit to which were attached 28 fire alarm stations well distributed and an annunciator and continuous ringing bell in the boiler house close to Pier "D" where alarms were received and sounded on the steam whistle. Current supplied by 12 dry cells. Boxes consisted of ordinary push button under glass guard.

TUG BOATS: The Erie Railroad Company maintains a fleet of five tugs which operate mainly in the North River. At least one of these tugs is berthed at the Weehawken Terminal for fire protection service at night time. These are equipped with pumps having capacities ranging from 250 to 750 gallons per minute. They carry a crew consisting of a captain, engineer, stoker, and two deck hands. The P. R. R., D. L. & W. R. R., C. R. R. of N. J., L. V. R. R., and the N. Y. C. R. R. each have a fleet of tugs, most of which are similarly equipped.

PUBLIC FIRE PROTECTION: The public water supply is not extended to cover this property. The Weehawken Fire Department which covers this terminal is a part paid and part volunteer organization consisting of two engine and two hose companies. In addition to a volunteer force, Company No. 1 has three, and Company No. 3 has five full-paid men. The force of the other companies is entirely volunteer. The apparatus consists of two 750 g. p. m. automobile pumping engines and two automobile combination chemical and hose cars.

Weather Conditions.

The records of the nearest weather bureau observation station, which is in New York, show that the temperature ranged from 43 degrees at 11 P. M. November 3rd to 39 degrees at 5 A. M. November 4th. These records also show direction of wind and velocity as follows:

Time	11-12	12-1	1-2	2-3	3-4	4-5
Direction	S.	S.W.	S.W.	W.	S.W.	W.
Velocity	2	7	11	15	17	17

Origin of Fire.

The watch clock records show that on November 3rd the watchman patrolled the first and second floors of Pier "D" between 10:47 P. M. and 10:55 P. M. Just before leaving Pier "D," to patrol Pier "F," he met three members of a train crew who had gone to pull some cars from this pier; the locomotive standing outside the pier shed. Returning to Pier "D" at 11:30 P. M. he found the locomotive and crew had gone. Shortly thereafter he started the second round by punching one station on the shore end of the first floor and then proceeded to the second floor, shore end. When within a few steps of the door on the second floor he heard a dull explosion. The door, when opened, slammed shut. Opening the door a second time he neither saw nor smelled smoke but did see a glaring light toward the end of Pier "D" and heard a roaring noise. He attempted to turn on the electric lights on the second floor, but the closing of the switch brought no effect. Realizing that something was radically wrong he descended the stairs to the first floor to send in an alarm of fire and found heavy clouds of smoke moving toward the doors at the shore end. This is all that is known of the origin of the fire. It is possible that the cause of the fire may have been either one of the following: smoking by the train crew, defective electric wiring, ignition of flour in contact with steam pipes, incendiarism.

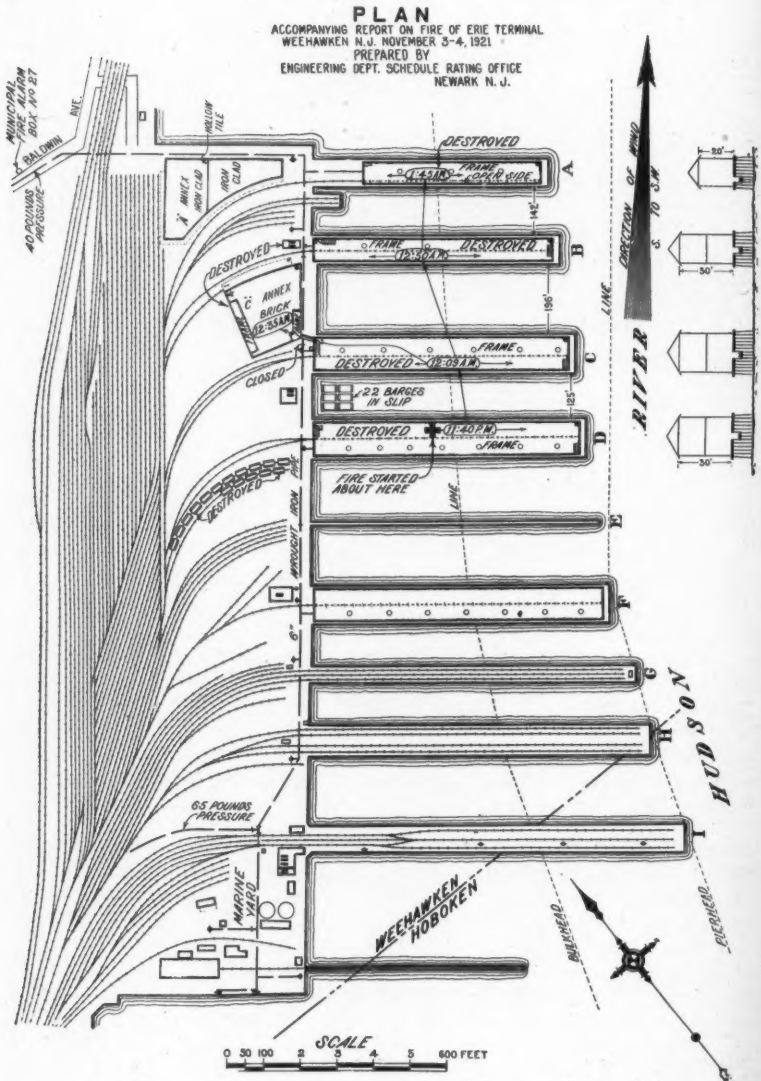
Alarm of Fire.

The Weehawken Fire Department records show that at 11:40 P. M. an alarm was received from Box 27, located on Baldwin Avenue near the Erie yards; this was pulled by a watchman who saw the flare in the sky. The watchman on Pier "D," after descending from the second floor, rushed to the boiler house, about 100 feet distant, and notified the engineer who sounded the alarm on a whistle.

Progress of the Fire.

In the diagram is given the location of the origin of the fire and the approximate time at which it spread to the different piers. The arrows indicate the direction in which it spread. The time given is, as stated, only approximate; it is based on the stage of the fire as observed by the various fire department officers on their arrival, the time of which is fairly accurately known, and on statements by employees of the Erie Railroad who could fix a time at which certain stages of the fire were seen.

At 11:40 P. M., when the alarm was sounded, both the first and second floors of Pier "D" were involved, and the flames had burst through the side walls. At 11:58 P. M., eighteen minutes later, Pier "D" was thoroughly ablaze on both floors from end to end with flames shooting out of the side walls and roof. The direction of the wind at this time was from the south but at a very low velocity, two miles per hour. Soon the numerous covered barges moored in the slip took fire. At 12:09 A. M. practically all of the barges in the slip between "C" and "D" were ablaze, and the water end and south side of Pier "C" were burning briskly. By this time the hawsers of most of the barges had burned through and the flood tide, which was running, carried a number of the barges into the river and finally into the slips between Piers "A" and "B" and the slip between Piers "B" and "C." Pier "C" was fully ablaze at 12:35 A. M. About this time the wind veered from the south to the southwest, and the


PLAN
ACCOMPANYING REPORT ON FIRE OF ERIE TERMINAL
WEEHAWKEN N.J. NOVEMBER 3-4, 1921
PREPARED BY
ENGINEERING DEPT. SCHEDULE RATING OFFICE
NEWARK N.J.
MUNICIPAL FIRE ALARM BOX NO 27
RAILROAD AVE.
40 POUNDS PRESSURE
YELLOW TILE
"A" ANNEX IRON CLAD
IRON CLAD
DESTROYED
(1:45 A.M.) FRAME COVERED SIDE
A
145'
DESTROYED
FRAME (12:30 A.M.)
DESTROYED
B
"C" ANNEX BRICK (2:35 A.M.)
195'
CLOSED
FRAME
DESTROYED (12:05 A.M.)
C
22 BARGES IN SLIP
125'
DESTROYED (12:40 P.M.)
FRAME
D
FIRE STARTED ABOUT HERE
(DESTROYED)
WROUGHT IRON PIPE
LINE
E
F
6"
G
H
65 POUNDS PRESSURE
I
MARINE YARD
WEEHAWKEN
HOBOKEN
DIRECTION OF WIND
S. TO S.W.
RIVER
HUDSON
BULKHEAD
PIERHEAD
SCALE
0 50 100 200 300 400 500 600 FEET

velocity had increased to about seven miles per hour. With Piers "C" and "D" and the barges between them burning fiercely, a tremendous blast and heat wave was carried across the 196-foot slip, the heat of which banked against the two-story frame side of Pier "B" throughout its entire length of 700 feet until the side of Pier "B" burst into flames at about 12:50 A. M. Some witnesses contend that the burning barges and debris assisted in carrying the fire to Pier "B" but this had little or no influence on the final outcome. With Pier "C" thoroughly ablaze the fire communicated at about 12:35 A. M. to the bridge and frame asbestos covered side of the four-story Warehouse "C" Annex. In a short time this building was entirely involved and within an hour the walls collapsed. About 1:18 A. M. Pier "B" was a mass of flames. The direction of the wind was still from the southwest but the velocity had increased to about eleven miles per hour. The heat wave developed by the three burning piers fanned by the eleven-mile wind was of such intensity and volume that Pier "A" ignited throughout its entire length at about 1:45 A. M. At 2:00 A. M. Pier "A" was burning fiercely with frequent minor explosions of the metal oil containers.

Warehouse "A" Annex, a one-story iron clad oil storage building, located 180 feet north of Warehouse "C" Annex was attacked several times but the fire fighting forces succeeded in extinguishing these each time. As there were no other combustible structures in the path of the fire it burned itself out.

While no definite information is available it has been reported that small flying brands were carried across the river to New York City, reaching as far as Broadway and Forty-second Street.

How the Fire Was Fought.

LAND FORCES: The Deputy Chief of the Weehawken Fire Department and Engine Company No. 1 with three men arrived at Pier "D" at about 11:44 P. M. The engine was set to draft from the slip south of Pier "C"; one line was laid and a stream with a reach of about 70 feet was directed on the south side of Pier "D." Engine Company No. 2 arrived at about 11:45 P. M. with five men and took a position south of Pier "D" drafting from the slip; two lines were laid from this engine and streams from each directed on the south side of Pier "D." At 11:50 P. M. some employees of the Erie Railroad assisted in taking a line to the roof of Pier "D"; this operation was limited to a distance of 50 feet from the shore end and the position was tenable only for about five minutes. Companies No. 2 and No. 4 with volunteers only arrived at about 11:55 P. M. and laid two lines, one from each engine, which were directed to the south side of Pier "D." About this time the Deputy Chief summoned aid by telephone from Hoboken, New York, Union Hill and Jersey City. At about 12:05 A. M. the position of Engine No. 1 was changed on account of the untenable position south of Pier "C" and placed in a position at the slip north of Warehouse "A" Annex. Streams from this were then directed against the shore ends of Pier "B," Warehouse "C" Annex, and later the shore end of Pier "A" and to protect Warehouse "A" Annex.

Soon after the arrival of the Hoboken engines, two engine companies each from Union Hill and Jersey City arrived. These were located along

the slip north of Warehouse "A" Annex and supplied streams directed on Warehouse "C" Annex and "A" Annex, and the shore ends of Piers "A" and "B."

MARINE FORCES: An Erie tug moored at the south side of Pier "F" responded to the alarm about 11.42 P. M., proceeding to the slip south of Pier "D." Streams from the deck pipes were directed on to the pier shed, but these were of little or no effect as they did not reach the seat of the fire on either floor. As nearly as can be determined other tug boats began to arrive at about 11:50 P. M. and continued to arrive for approximately one hour until in all some 37 tug boats owned by the various railroads were on the scene. Most of these entered the slip south of "D" and played deck pipe streams on the pier shed but these too had little or no effect. Several of the tugs manoeuvred about to prevent burning barges from getting into mid stream and into the adjacent slips. It is reported that from two to four tugs attempted to operate in the slips between Piers "B" and "C" and between Piers "A" and "B" but such operation was of very short duration and extended but a short distance in from the water end as these slips were untenable.

At 12:01 A. M. Engine Company No. 86 of the New York Fire Department (Fire Boat "Thomas Willett") received instructions to respond. Eight minutes were required to reach Pier "D." This boat operated for two or three minutes on the water end of Pier "D" and then for about ten minutes on the water end of Pier "C." An attempt was made to enter slip between "B" and "C" but on account of the intense heat this plan of operation was abandoned. The subsequent operations were at the water end of Pier "B" and on the north side and water end of Pier "A." During the larger part of the time this boat provided five 2-inch streams from the deck pipes and water tower.

At 2:01 A. M. the fire boats "New Yorker" and "Strong" of the New York Fire Department responded. The former required twenty-five minutes and the latter thirty-seven minutes to make the run. On arrival at the fire their commanding officers found the sheds of Piers "B," "C," and "D" down and "A" completely ablaze. Positions were taken on the north side of "A" and deck pipe and water tower streams of a heavy caliber were discharged into Pier "A."

At no time during the fire was an attempt made to use the yard hydrants.

Property Loss.

Piers "B," "C," "D," and Warehouse "C" Annex, and what was known as "B" Boiler House were totally destroyed with their contents. Pier "A" was almost a total loss. Of the 22 barges 12 of them were totally destroyed and the remainder damaged to various degrees. In addition some 16 to 20 freight cars were destroyed. The loss on buildings, barges and cars was $1,753,550; on contents, $555,387, making a total loss of $2,308,937.

Conclusions.

The information and experience gained adds but little to what is already known of the possible consequences when this class of pier construction is exposed to fire. In fact, following a survey in 1918, of the water front the possibility of a disaster of this kind at this location was

Pier "A" where the fire was finally stopped. The proximity of the fire to New York City can be seen by the skyline in the background.

anticipated. However, a review of the conditions that made so rapid, destructive and uncontrollable a fire possible should serve to emphasize and direct attention to the importance and necessity of a radical change in the construction and protection of piers and wharves, if such disasters are to be averted in the future. It may be well to add that a record including 107 fires on piers and wharves up to December 31, 1920, shows a total loss of $33,555,382 or an average of $313,601 per fire, an alarming figure.

With reference to these piers it may be said that they were built to burn. They were of frame construction; each formed a long horizontal flue; the areas were excessive; the safeguards comparatively meagre; the accessibility from land (as usual) limited to a narrow end; the solidly closed sides made effective attack from the water impossible after a pier was once ablaze; the slips between the piers were unusually narrow, and the value of the narrowest slip as a partial fire break was largely destroyed by the numerous barges with frame housing. The piers individually and as a group created a high potential hazard which could have been mitigated only

(*a*) by the installation of a standard system of automatic sprinklers,
(*b*) by the erection of fire walls at 200-foot intervals on each pier, and
(*c*) by the installation of outside sprinklers along the sides of the piers.

Still other improvements could have been made to reduce further the high potential hazard. These improvements would have insured the full and effective utilization, on the actual seat of the fire, of the resources of the private and public fire protection provided by the land and marine forces, the combined effect of which would have resulted in a low probability hazard. The lesson taught by this fire is not new but it does confirm and emphasize the forecasts of the past, namely, that failure to apply to marine structures the fundamental principles of fire safeguards as developed for land structures invites disaster.

Too frequently owners of such properties seem to consider that the fire hazard problem has been solved, and remain content and satisfied under the false sense of security inspired by the installation of casks and pails, hand extinguishers, standpipe system, watch service, and some outside protection (the use of which is generally limited to the narrow shore end), especially if there is some marine equipment and public fire boats.

As a matter of fact all of these agencies failed utterly at this fire. The hand fire protection had a value but, in this case as in many others, the fire had gone beyond the useful effective limits of these appliances before the personnel arrived to utilize them. In Pier "D" there was no physical means, such as fire walls and automatic sprinklers, to check the initial spread of fire. Therefore, Pier "D" became so thoroughly fire swept that the use of the appliances installed was lost. The intensity of the heat banked against the exposed walls of Piers "C," "B," and "A" successively ignited these piers because of the absence of outside sprinklers and because of the fact that the hand protection could not be applied effectively throughout the great length of sheds.

The security that the public fire department could afford was likewise grossly overestimated. When piers, such as these, are once involved or exposed to an intense heat wave, the value of the land equipment and the operations of the land forces are limited to a very short distance from the shore end, usually 50 to 100 feet.

The defeat of the marine forces under the ordinary methods of operation, which were used at this fire, was to be expected after Pier "D" was fully ablaze. Under this condition landings on this pier were impossible and the streams from the deck pipes and water towers of the boats were ineffective because they could only be discharged against the side walls; these were without window openings, the common practice in pier construction, through which outside streams are generally discharged when ordinary buildings are on fire. Then, too, after the fire had burned through the side walls and roof, these streams could be applied only on one side of Pier "D" as all the slips on the lee side became untenable as the fire progressed. The only conceivable way in which the fire boat equipment could have been made effective would have been by entering the slips on the lee side of the fire with at least four and preferably six powerful boats in two column formation, the rear column to provide a water barrage or screen thrown over the front column to break the heat wave and the front column of boats to operate against the fire. The practicability and possible success of such an operation are questionable because of the improbability of assembling such numbers of powerful boats for timely operation at such a quick burning fire.

It is generally agreed by those officers who were in command that had ocean vessels been berthed at these piers they would have suffered enormous losses and likewise if there had been additional piers north of Pier "A," similarly constructed and spaced, they too would have been consumed.

In the light of previous knowledge and the added experience from this fire it can be stated without fear of contradiction from any source that may be considered authoritative, that in new constructions the maximum degree of safety can be secured only by:

(a) Fire resistive construction where bottom conditions will permit and by the application of modern principles developed for the protection of land structures.

(b) or where bottom conditions will not permit fire resistive construction, the new construction should be, except for the walls, what may be considered as approximating mill construction for buildings and having the modern principles of protection for safeguarding land structures applied.

In the same light and in the same way it may be said that the maximum degree of safety for existing structures can be secured only by a rigid application, so far as is possible, of the modern principles developed for the protection of land structures.

Fires in Which There Was Loss of Life.

These notes are intended to point out typical conditions under which loss of life has occurred, that they may be known and guarded against.

Gasoline.

H17347. Washington Courthouse, Ohio. This fire occurred in a little two-story frame farmhouse with one room upstairs and the other down. The house was occupied by a farmer, his wife and four children. The baby became ill during the night and the father arose to heat some water. In starting the fire he mistook the gasoline can for the coal oil can. He ran from the house in flames, and died a few hours afterward. The house was totally destroyed. The wife and four children were burned. There was no fire protection of any kind available.

H17460. Woonsocket, R. I. A man stopped at a garage for gasoline, and while the employee of the garage worked the pump he stood watching nearby. When the employee withdrew the hose he whirled to hang it up in its usual place and gasoline spilled over the front of the other's clothes. The latter paid no attention to this, however, and started to light a cigarette. His clothes instantly took fire, and he threw himself on the ground, while employees of the garage attempted to put out the fire with chemical extinguishers. He was burned beyond recovery.

H17462. Burlington, Wis. A woman was cleaning a suit of her husband's clothes, with a pan of gasoline on the floor of the laundry. An open gas flame was burning on the wall and fumes from the gasoline communicated with this, causing an explosion which cost the lady her life and practically destroyed the house.

Oil.

H17452. Conrad, Mont. The father of a family was pouring oil out of a three-gallon can into a heating stove. The stove and can exploded. An open stairway communicated to the bedroom upstairs, and the fire

poured up this stairway, shutting off the escape of three children and the mother. All of them were burned to death before firemen could come to the rescue.

H17477. Everett, Mass. Explosion of an oil heater caused the death of a woman. Her clothing caught fire, and although neighbors immediately went to the rescue she was so badly burned that she soon died.

H17472. Cambridge, Mass. Four brothers were burned to death in the attic of their home when an oil stove at the head of the stairs on the second floor exploded. The rest of the family on the lower floors of the dwelling were able to escape, but the rapidity of the fire and the denseness of the smoke cut off the attic from the rest of the house. The boys were all asleep and did not wake until it was too late for their escape.

H17446. St. Andrew, Fla. An oiler in a lumber factory went down under the building to locate a hot bearing. He oiled the bearing, which almost immediately took fire, and the flames were carried by the belting all over the building. The fire spread so rapidly that the employees had to jump out of windows to save their lives. One man was unable to escape and was burned to death.

Hot Ashes.

H17390. Sylacauga, Ala. Fire started in the kitchen, due to carelessness in leaving hot ashes unattended. The family was able to get out of the house, but a woman ran back to get some money she had left and was burned to death. The same family had lived in this house when it had burned less than a year before.

Bonfire.

H17505. Lawrence, Mass. A two-year-old boy died as a result of burns when he walked into a paper bonfire which his five-year-old sister and her girl chum had started in the yard in the rear of their home.

Children Left Alone.

H17486. Seattle, Wash. Two little children, one four years old and the other two, were locked in their home while their mother went a block away to visit. When she left there was a good fire burning in the kitchen stove, and the children were asleep. Upon her return she found the house burned to the ground. Neither child was able to escape.

Automobile Wreck.

H17459. Baltimore, Md. A driver of a new car was rounding a turn at a speed of 80 miles an hour when the vehicle struck a telegraph pole and caught fire. Two men nearby were attracted by the sound of an automobile horn blowing continuously, and on investigation found the machine, a mass of burning ruins, beside the road. The telegraph pole had been uprooted and was also ablaze. They raised the burning car and extricated a woman who was wedged in beneath the debris. It was not until after the arrival of the firemen that the man's body was discovered in the machine. He was wedged in so tightly behind the steering gear that it was necessary to cut away parts of the machine to free him. The woman was not touched by the fire but was badly injured.